Vol. 5 NOVEMBER, 1922 No. 11

Journal
of the
American Ceramic Society
Ceramic Abstracts and The Bulletin

A Monthly Journal devoted to the Arts and Sciences Related to the Silicate Industries

CONTENTS

Original Papers: Page

Ceramic Art and Archaeology Abroad 743

The Organization of a Successful Ceramic Research Department—Rhead 758

Effectiveness of Different Methods of Making Absorption Determinations Applied to Hollow Building Tile—Foster 788

Investigations of Dust Press Practice as Influencing Finished Sizes and Cracking—Sparrier 798

The Effect of Sources of Pig Iron upon the Enameling of Cast Iron—Manley 806

The Relative Merits of Heat Resisting Alloys for Enamel Burning Muffles—Forde 811

The Chemical Combinations of Dolomite and its Use in Sorrel Cements— 817

News of Some Rivals—Addison 823

Value of Pulverizing From a Manufacturer's Standpoint— 826

Some Observations on Old Method of Applying Glazes—Manshaw 827

The Effect of Some Fluxes on the Absorption and Transverse Strength of a Terra Cotta Body—Hill 832

..... 265

Bulletin 267

..... 269

..... 296

"The Relation of the Calcination of Flint and Chalced- 298

..... on Slattering of Terra Cotta 301

..... Viscosity of Indiana Clay Slip with Electro- 303

..... Casting of Terra Cotta 304

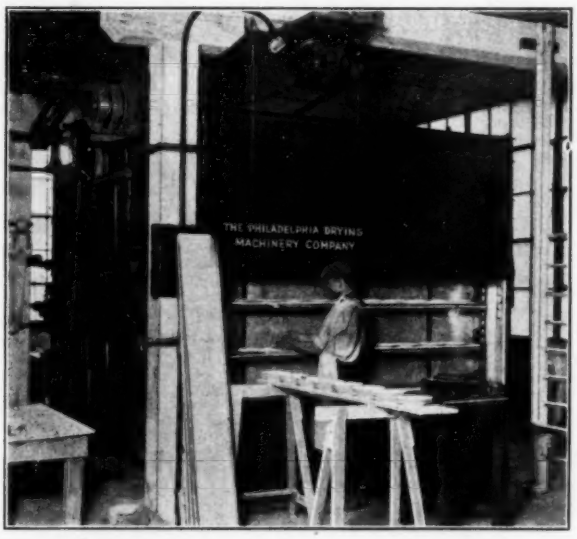
..... of an Investigation of Some Georgia 305

..... Materials for Cast Iron 310

..... 316

..... 325

"HURRICANE" DRYERS



Automatic Mangle for China and Porcelain

"Hurricane" Automatic Mangles are saving many prominent pottery concerns time, labor and operating expense, using a minimum of floor space.

By the "Hurricane" Continuous method of drying Dinner Ware, it is possible to eliminate much finger marking and scarring, and turn out better finished products.

Our experienced engineers are at your service to aid you in solving your drying problems.

The Philadelphia Drying Machinery Co.

Main Office and Works
3351 Stokley St.

Philadelphia, Pa.

Boston Agency
53 State St.

HF&G

HF&G TIN OXIDE

THE HARSHAW FULLER AND GOODWIN CO.

Cleveland

Chicago New York Philadelphia

(When writing to advertisers, please mention the JOURNAL)

JOURNAL

OF THE

AMERICAN CERAMIC SOCIETY

A monthly Journal devoted to the arts and sciences related to the silicate industries.

Publication Office: 211 Church St., Easton, Pa.
Editorial Office: Lord Hall, O. S. U., Columbus, Ohio.
Advertising Manager: L. R. W. Allison, 170 Roseville Ave., Newark, N. J.
Committee on Publications: R. H. MINTON, Chairman; H. F. STALEY, CHESTER H. JONES, E. W. TILLOTSON, ROSS C. PURDY.
Editor: ROSS C. PURDY; **Assistant Editor:** EMILY C. VAN SCHOICK; **Associate Editors:** L. E. BARRINGER, E. W. TILLOTSON, ROY HORNING, R. R. DANIELSON, A. F. GREAVES-WALKER, F. H. RHEAD, H. RIES, R. L. CLARE.

Entered as second-class matter July 15, 1918, at the Post Office at Easton, Pa., under the Act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 16, 1918.

(Copyright 1922, American Ceramic Society)
Eight dollars a year Single numbers, 75 cents
(Foreign postage 36 cents additional)

Vol. 5 **November, 1922** **No. 11**

ORIGINAL PAPERS

CERAMIC ART AND ARCHITECTURE[1]

BY GABRIEL FERRAND

I did not want to miss this occasion to instruct myself, of the progress made in American pottery; and secondly, of the possibilities offered by American ceramics in the field of architecture. There are two kinds of terra cotta, one for exterior and the other for interior use and I shall take these up respectively after we have completed a brief review of the uses of terra cotta during the past centuries.

Since a very early time the art of pottery, or ceramics, was applied in a number of ways to great advantage. Assyrian and Babylonian civilizations have left us some wonderful examples of the application of terra cotta and colored glazed brick to produce a monumental effect in architecture. We also know that in Persia and other Asiatic countries many a mosque, palace or mausoleum has been decorated with tile, the color of which is very beautiful. Reproductions of these works are well known. Suffice it to mention one example that is known by everyone, namely, the Taj Mahal.

Then we were shown some examples of pottery belonging to Chinese art. In China, mausoleums and temples, as well as palaces, were decorated with a sort of an antefix much similar to that of the Greek, always placed

[1] Address delivered before the Art Division of the American Ceramic Society on March 1st, St. Louis Meeting.

on top of the roofs of tombs and structures protecting Chinese graves. This kind of pottery or ceramics is the very kind applicable to architecture.

The Greeks and Romans, in turn, used terra cotta, and we saw some interesting illustrations of that use, but in Europe we have to come to the early Italian Renaissance to find such use of ceramics greatly enlarged through the genius of the Della Robbias. They knew how to handle clay, and the Italian architects of their time knew how to apply it to their buildings. In fact, it is in that part of Europe that the foundation for extensive use of terra cotta was laid, and the Italian name which means "baked earth" is so expressive of the nature of this material that it has passed through Italy to us and probably will be used forever.

Terra cotta in Italy is applied in a very interesting manner. May I recall those beautiful churches such as are found in Florence, Fiesole, Bologna, etc., and especially that admirable Certosa in Pavia. Many people have no idea of the charm that is found in Italian towns and cities where large buildings as well as small structures are decorated with glazed and colored terra cotta. It is, indeed, quite a refreshing and welcome change from the aristocratic elegance of marble or stone, or the simplicity of brick, and there is no doubt in my mind about the great future of terra cotta in architecture.

We also find splendid examples in Spain of the Moorish architecture. I may mention the Alhambra, the Alcazar and the Generalife, or the cities of Granada, Cordova or Seville that will suggest a splendid display of color to be seen, not only in Spain, but in Northern Africa as well, where the application of colored and glazed tile is found in practically every building of importance built by the Moor or the Spaniard.

We now come to modern times, I mean to the last three centuries which are nearest to our present age. We admire works of Bernard Palissy, one of the greatest, if not the greatest, among French potters, and one who sacrificed everything for art's sake and whose name will forever star in the history of ceramics. There is, however, one period of which perhaps few of us know. We all have heard about Versailles, but besides the Chateau itself, there exists two other smaller structures called respectively The "Grand" and "Petit" Trianon. Before the erection of the Grand Trianon there was in the same spot another Trianon called the Trianon de Porcelaine, erected by the King of France, Louis XIV, for Madame de Montespan. As the name implies it was a structure made of brick entirely covered from the ground to the top with porcelain panels and tiles, glazed and colored. One of the contemporary writers tells us that "when one enters the garden one can view it, all covered with faience works, porcelain urns and vases of various kinds which produce an effect unique in the world." This effect was chiefly produced with two colors, the white and the blue, with touches of gold. The vases were also white

and blue, Chinese fashion, and even the boxes containing orange or laurel trees were decorated with white and blue paint, to harmonize with the porcelain itself, fragments of which still exist in the Versailles Museum. This building, which, if we believe the descriptions made of it, was one of the marvels of that period, was demolished to satisfy the whim of the king. The wishes and fancies of those monarchs were so ever-changing, that when any building had ceased to please them, they simply called on their architects to build something else, regardless of cost.

This procedure, however, seems responsible for some of the finest masterpieces that have been preserved to the present day. If it were not for the lavish expenditures made to satisfy the fancies of kings and potentates, we could not admire today those resplendent works because they would never have been built. Kings have disappeared and democracies have taken their places. One would believe that with the advent of the republican form of government, such gorgeous structures could not be possible. But, we again find splendid modern examples of the use of terra cotta in monumental edifices built during the first year of this 20th century. There is a lapse of about 150 years between the Trianon de Porcelaine and the International Exposition of 1900 in Paris, but it is nevertheless gratifying to see that the use of terra cotta has been revived on a large scale. We shall recall, briefly, what happened at that time. The French architects, appreciative of the splendid effects obtained in the past by their predecessors, decided that they had a unique opportunity to make use of terra cotta on an extensive scale in monumental architecture, and especially in two of the exposition buildings, facing one another called respectively the Grand and Petit Palais. The Grand Palais, however, is the one which presents the most pleasing decorative effect with two large friezes, illustrating some episodes of the history of France or the city of Paris. One of these friezes is unprotected and laid on the outer surface of the wall entirely exposed to the elements, while the second is found under a portico affording ample and adequate shelter. No better example of the modern use of terra cotta could present us with that sort of directive for the future we so much need. When these palaces were built and especially the larger of the two, every architect, every citizen of Paris and France was interested in the attempt which was not, indeed, new to French architects, but still looked on as a new venture in that field. I saw these works when started and saw them when completed. They have fully produced the results which were expected, and they present that very touch of color which breaks the whiteness and monotony of the stone, however beautiful the stone may be in France.

There were also other examples of a purely decorative nature. I shall only mention a fountain made of Sevres ceramic which has been preserved and is at present decorating a party wall facing the garden of the church

of Saint Germain-des-Pres. Besides, there are the façades of many a plebeian apartment building, for the decoration of which the potter and the ceramist had to contribute their best talent.

I stated a while ago that we have two uses or two different manners of using pottery or terra cotta, one for building exteriors and the other for interiors, and each calls for a different kind of material. To be more precise, we should say that the effect of color, to be satisfactory, must differ for both, and this for obvious reasons. We all know that color placed outside will fade when exposed to sunlight or at least appears lighter. No better example can be found than that of the painter who, in his studio, depicts sunlight atmosphere such as in a sunset or sunrise scene. He has seen magnificent coloring which he tries to reproduce on his canvas. When through with his work, let us assume he is quite satisfied with it and congratulates himself. Then he takes it out of doors and looks at it under the sunshine, but to his great surprise it has faded away and those colors that looked so gorgeous and, perhaps, riotous in the studio, are absolutely gone. This is the very change in values of coloring we have to remember.

I am speaking from the viewpoint of the architect and not touching upon the technical phase of ceramics, because if I must confess I know so little about either the technical or the chemical sides of this subject, I am, however, cognizant of the main principles of pottery and realize the opportunities which are offered through the use of ceramic products. These I want to emphasize and should like to tell members of the American Institute of Architects that too often the cause of some of our failures is that we all are too conservative and do not dare enough. Architects, are too opposed to change or progress.

We know that we may appeal to ceramists to provide us with fine work to put on our façades, but we also know that if we do not take the initiative you can not well be given the opportunity for such fine work. We are to conceive and you to execute. We are to be, to an extent, the directors of your work, but we must first ask you what can be done. There are limitations in your field, as well as in architecture or any other human enterprise. It is only the craftsman or the artist, experimenting constantly with his materials and his colors, who fully knows their possibilities and their limitations, what colors are fast and ought to be used, or what others will fade and should be discarded. The architect, therefore, comes to you and asks advice on that subject, but you must rely on him for general design and color effect.

The use of terra cotta is susceptible of many varied expressions. It may be used as friezes or as panels, or in a number of different applications. The Babylonians used them extensively as friezes of large figures, beautifully treated in a very bold manner. They were of such large scale as would permit of viewing them at a great distance. They never were lost

in the general design on account of smallness of details or minuteness of the elements that enter into their composition. Splendid examples of decorative scale were they. *Scale* is the most difficult of all the requirements of good composition and is very often misused or misunderstood. It should vary according to its use, as interiors are different from exteriors. But we must not forget that however beautiful and to the point a detail might look on the inside, it will be lost on the outside. We all appreciate the importance of scale in architecture, and most especially in its relation to the human figure and the average distance that will exist between the object and the onlooker's eye. We should never forget these variations.

The architect who wants to use pottery or terra cotta will come to you with some requirements or specifications, as he does for any other building material. What ought to be these specifications? What ought to be these paramount requirements?

The first should be one of *durability*, essential to every lasting material. It is up to you to find such material as will defy time, as will stand untouched by the destructive action of the elements. The answer to this requirement is plainly up to the potter and the ceramist; not to the architect.

The second requirement would concern *color*. To provide for the color which will enable the architect to make his dreams become true is again a matter for the potter, or rather for the chemist working side by side with him. The different colors used should be fast and unchanging, and should harmonize with the other materials used in the building. Here we may take our lessons from the past and try to emulate what the Oriental, the Greek, the Arab, the Italian, and others have done in that field. If we use stone or brick the color of our terra cotta will have to be either in contrast with the background or in harmony with it. It is wholly up to you to advise the architect as to what possibilities terra cotta, either mat or glazed, may offer and show him such samples as will enable him to select the color that will produce the desired effect, and as can accurately be reproduced in the finished product.

The third requirement, and perhaps not the least, is that of *cost*. Up to the present time this cost has proved to be, in many cases, a great stumbling stone. If it were possible to obtain on a commercial scale terra cotta of a beautiful nature, for I have always in mind quality as well as quantity, if it were possible to obtain splendid medallions, at reasonable prices, (and please notice I do not say moderate but reasonable), there is no question but that the future use of colored terra cotta in architecture would be fully insured. It would be very bright and I am convinced it would not take long for the people to get so enthusiastic about its use as to see it soon become a fad. This we ought to avoid. It certainly should not become a fad, but only a logical and sensible application of a beautiful material for the greatest benefit of architectural expression.

Among the samples exhibited at the St. Louis meeting there were some clever tricks played in terra cotta. There were fine imitations of granite, marble and other materials. I certainly am not in sympathy with such uses. Why should terra cotta, which possesses such a wonderful plasticity, try to become a mere imitation of other materials which do not possess it? Why make it so closely to resemble marble, which is altogether a different material and can not be imitated, at least in that way? Why force it so accurately to imitate granite that at a distance the substitution can not be detected by the eye? Deceit in art has never been successful for a long time. We remember how strongly Ruskin condemned it. Although I do not accept to every statement Ruskin made about architecture, because their strict application would prevent some of the progress made in this century, I am satisfied to subscribe to that special statement of his so far as it concerns terra cotta. In trying to deceive, terra cotta is entering into a channel for which it is not intended and for which it is not made. The field of its application is large enough without trying to make it, as we might say, "play second fiddle," while it can most successfully play first.

Another matter to be considered is that although the architect is beginning to realize the decorative value of colored terra cotta in some parts of the country, he has not yet done so in this middle west. Only few attempts, and very timid ones, have been made and this is to be regretted. I have seen so many beautiful examples in the old world that I am wondering why, in this new world, so replete with opportunities of all kinds and where there exists such a large field for the application of terra cotta and pottery, the architect has not taken full advantage of these multitudinous opportunities. I said a while ago that the architect is, generally speaking, too conservative and his daring too limited. It seems to me that such conservatism has gone the same way as that of the peasant who, in order to economize, gradually cut down the food allowance of his donkey until it died. He could not understand why, since his donkey had been working until the very last minute and seemed to be getting used to starvation, it should die. I can not help but think of this when I see beautiful examples of a past, which we all so greatly admire, discarded by our present generation for a more conservative use of the materials. I have always been so lured by color, either used in monumental architecture or applied to more modest domestic buildings as to make me deeply regret that we architects of the present day are not taking more advantage of it. It looks as if the architect had by degrees eliminated its use until, on account of its total absence, most of our present buildings have become uniformly monotonous. And yet, nothing will more enhance the beauty of a stone or marble structure than color when judiciously located; not distributed everywhere, but only in a few selected spots where it will better contrast with the stone or the marble, so as to make it look more beautiful and

more charming to the eye. It is what I hope every architect will realize in time. Then the day will come when, through the impulse your association will give to the application of colored terra cotta and its manifold possibilities, it will be used extensively by the members of our profession.

You can not, however, depend solely on the architect. Go to him and show him your productions, bore him, if I may say so, with your wares, annoy him to the point when, in order, to get rid of you, he will give you a chance. Then, after he has realized and seen what you can produce, I am confident he will be so pleased as never to stop using your material. This has been my very experience. After all, the architect ought to be a man of progressive ideas, always ready to try the use of those architectural elements that may enable him better to realize his conceptions and to express the creations of his mind.

SCHOOL OF ARCHITECTURE
WASHINGTON UNIVERSITY
ST. LOUIS, MO.

Discussion

MR. E. C. HILL:—I have been quite interested in Prof. Ferrand's address. I do not know whether I understood him about the fading of terra cotta when used for exterior purposes. I do not believe the color we make will fade other than as it becomes dirty.

PROF. FERRAND:—You know what colors can best be used for that kind of work, and that is the point I was trying to raise. It is, indeed, up to you to go to the architect and make him aware of the qualities of those colors. I know that here in St. Louis there have been a few attempts to use colored terra cotta for exterior purposes. In addition to a certain number of small structures we have the Moolah Temple, the house of the Shriners. Now I have often heard its architects say that they were somewhat disappointed because they could not get the very colors which would produce the intended effect as they expected.

It may happen that the architect will be unreasonable, though I know more thoroughly, perhaps, than you do what his limitations are. If he is unreasonable it is up to you to tell him frankly that his plans are not practical. It would be better than granting him anything he wants if it is not within reason.

Now, if you choose to withhold your practical advice you will find you can not live up to your promise. You also know that when unsatisfactorily colored parts come to the work and are erected, they are bound to disappoint the architect who most probably expected a better harmony of colors. I know very well that if you have colors which will not fade and are durable, the variety of those which are desirable for the decoration of exteriors is certainly limited.

MR. SHEFFIELD:—It is all very well to talk of architects and art in a

meeting. I have noticed that the architects themselves, seem to get an entirely different atmosphere when they get together, and talk about their wonderful profession. They are somewhat different creatures however when you meet them in an office about business.

We have classified the architects, of today, in our office, as architects and "hashitects," and unfortunately, we have a great many "hashitects" to deal with, who insist upon certain things being done.

We also have limitations of the manufacturing establishment where we have to produce so much business a day in order to meet a large and growing pay roll. For thirty years our firm has been trying to preach these things mentioned in Prof. Ferrand's address. It is a good deal like the little peanut vender on the street, who says:

"We sella two things, da banan and peanut; all we make on da peanut, we lose on da banan."

Now we should like a little help. Our men are working all the time, trying to perfect their ware and their color, and the only thing we can say about the use of color is that we believe there is a great field for terra cotta in the United States in the use of color. But we hesitate to advocate it, for every time color has been used, the saddest thing about it is that it is fireproof and will last a long time.

Our work is condemned by the architect, when it is really his fault. We get very little sympathy from him. After working hard for months to perfect a color, or the texture that they want, they ask how much it is, and find that it is five per cent above Bedford stone, or some other material. They are very sorry that our material reflects the cost of taking pains.

However, we are gaining all the time, and we find that we not only have to educate our own men, but we also have to help educate the architect. So it is very difficult for a manufacturer to listen to these talks of idealism, even if I have a lot of it, myself. When I start to talk, they say,

"Behold, the dreamer cometh."

CHAIRMAN RHEAD:—We are going to dream, and we are going to work, but at the same time we are going to look for aid from the outside. When Prof. Ferrand finished his speech, I remembered a meeting we had in New York last year. I think it was at the Chemical Exposition. We invited J. Monroe Hewlett, who was president of the Architectural League at that time and if these two talks were compared they would be much alike. Mr. Hewlett used different words. He deplored the fact that while potters and terra cotta men had such a wonderful material available and so many wonderful possibilities, that all he succeeded in doing was to make a very bad imitation of granite. He rather exaggerated, but he expressed the same idea that Prof. Ferrand expressed. He was hoping, and suggesting, and advising that the terra cotta man use the full possibilities of this material.

It has been in my mind in regard to the American Ceramic Society that each time we have met for the last sixteen years we have talked about this matter and written about it, and have done an enormous amount of research work, but we have never had an exhibition. We have never shown what we were doing, not only among ourselves, but to the outsiders as well. By outsiders, I mean the architects and everyone else having some relation to the work of the terra cotta people, and people doing art work of any kind. It has been in my mind to show everything in some organized manner so that those interested may know something of the possibility of architectural terra cotta and faience.

I do not know how many terra cotta men are familiar with the Architectural League in New York, or how many are members of that organization. It is a most powerful architectural association, the most powerful in the country, and most of the leading men of this profession are members whether they live in New York or not.

This League has an annual exposition. At a recent meeting, there were two examples of architectural terra cotta exhibited.

MAJOR GATES:—I would like to ask Prof. Ferrand to explain a little more fully what he means by imitation of granite by terra cotta. Our old friend, Fritz Wagner, of the Northwestern Terra Cotta Company, once said:

"Simply because a combination of colors had been placed together before, was no reason why, when we made up a model sample of various colors, they should be called imitation."

Many architects do ask us to imitate granite, but we get so many different color effects in mottled surface, that I believe mottled is better than plain surface, and we do not think we are exactly imitating granite.

PROF. FERRAND:—Probably you do not knowingly imitate but you do so unwillingly. You are judged on results and not on intentions, which is quite different. I think that architects are often responsible for those "sins" if you let me so call them.

It is my privilege to educate young men in architecture, and I have found that the most difficult thing to do is to develop their imagination. If the architect had enough imagination, he could visualize at once the possibilities of colored terra cotta as a decorative element in architecture. But most architects are not naturally imaginative. They safely stick to the trodden path and do not want to go outside of it. They are satisfied with what has been done before. I certainly do not mean to speak against the architectural profession as a whole, or against the architect as an individual, but I am obliged to acknowledge facts. An architect once came to you and said he could not use granite on account of its cost and asked therefore if you could produce an equivalent for it. If he had never propounded the question you probably never would have thought of

answering it by substituting terra cotta for granite. This particular architect should be held responsible for it. He should have come to you wishing to obtain some such expression of *terra cotta* as would be the decorative equivalent of granite and when asking for the proper name this name should have suggested some sort of terra cotta, or be any new name you might have chosen for it, but a name which would not confuse it with granite. It is not granite and never will be.

There is no matter of greater import than the education of the architect. That education presents a difficult problem, too often solved unsatisfactorily. Let us consider that an architect has had some training, that he has studied under one or more good masters, that he has learned about different materials and made up his mind as to their respective use. Let us also consider that he has traveled in Europe and the old world, there to view the beautiful examples of the past, and that this has enabled him to discriminate between materials and their use, their respective function and their decorative effects, and finally let us take for granted that he can realize the value of colored or plain terra cotta in architecture. We will agree that if one has had such an educational opportunity he certainly would be justified in decorating himself with the title of "architect." Well, he may be so according to the general meaning attached to the word, but it does not necessarily ensue that his ability as a draftsman has provided him with imagination. Right there is the very difficulty which confronts architects as designers and you as producers. We all know that though a man may call himself an architect he may not be the kind of an architect the name implies and with whom you expect to work. As one of you said, there are "architects" and "ar-tchi-tects," but the latter will disappear in time.

And again, consider the present generation of architects. When architectural training was offered in schools or universities, about thirty or forty years ago, most architects were for the greatest part, untrained and architecturally uneducated. They were almost without exception draftsmen who had graduated themselves in architecture. Now we find that the younger generation who comes out of the architectural schools is better educated, better prepared and better trained than the older. Just remember the fact that the number of schools has jumped from ten, perhaps twenty years ago, to forty-four at the present day. This means that there are centers of architectural education and training practicaliy everywhere in the country, and that the young man who wants to enter the architectural profession has an opportunity of obtaining the right kind of education regardless of where he lives. It does not matter that his home be in Arizona or Southern Texas or New Mexico, or you might say even at the other end of this new world, he can today find a center of architectural training not far from his home and thus is not obliged to cross the continent to go east as was the rule a quarter of a century ago.

Ten years from now you probably will find that there will be more new centers and more new schools founded, every one of them with great ambitions. If, each year, you could attend the meeting of the Association of Schools of Architecture, you would see that those schools which are not members of the Association but nevertheless send representatives to the meetings do it for one reason only, namely, the benefit derived from the constant exchange of opinions among schools, rather than for the honor of belonging to the Association. That interest in the right development of architectural education has done more for the improvement of our schools and the courses offered by them than anything else I know of. You will find today in our schools young men who have a clearer understanding of our profession and of the opportunities it offers than was the rule ever before.

I referred to the daring of architects in my address. That daring can not exist unless it be prompted by *imagination*. If the architect has no imagination you, material men may for months and perhaps years, talk to him of the possibilities of colored terra cotta in architecture without result. He will be entirely deaf or will not listen, and if he listens he will not heed.

However, the time will come soon, let us hope, when the terra cotta manufacturer will find no difficulty in giving the architect what he wants, because he will find him more receptive and better aware of the proper use of terra cotta and of its wonderful possibilities. The day will come when the architect will call on the manufacturer as on a friendly collaborator with whom he will try to find out the best solution of his problem. He will come to his office as he does in regard to the specialized engineer and will say, "Tell me how far I can go in this application of your material. What is your opinion?"

The terra cotta man will be the expert. Just now the architect is not in the mood to listen because he thinks not of the possibilities of terra cotta when used as such. On the contrary he thinks only of terra cotta as a substitute for stone, granite, marble or any other material. This, in my mind, is entirely wrong. Terra cotta, excepting brick and hollow tile, should be used exclusively as a decorative and not as a structural element. One of its various applications I particularly wish to present to you. It is that which is found in some countries and large cities of Europe. You will find in Paris, Munich, Frankfort, Vienna, and elsewhere whole façades of buildings decorated with a special kind of terra cotta, called in France "Gres Cerame," and by some other name in other countries. This is nothing but ceramics applied to building decoration. Such use is not that of a structural element, but only that of a decorative one, mostly applied in squares, easier to handle, and also in other convenient forms not suggesting the use of stone in a structural way. This is precisely what I would

like to see here. I do not object to an applied front, if it is beautiful and treated in a manner that will make it recognizable at once, as in the Certosa in Pavia. But, whenever I see an imitation of stone or granite in terra cotta I frankly say I am not in sympathy with it. It is exactly what I meant to say a while ago.

MR. GATES:—Do you mean if any *surface color* which is not plain resembles the granite or brick or the block, that it resembles the *piece* of granite?

PROF. FERRAND:—No, I mean if it gives the impression of an imitation of granite.

MR. GATES:—My point is this, is it a pure, fast texture or surface block?

PROF. FERRAND:—It may be both and therefore have a tendency to create an impression that should be avoided.

I know you are now in the transitory period. Terra cotta use in this country has only started and its future, although no one can prophesy to what extent, is undoubtedly very great, because it is a material easy to apply on a surface and entirely fireproof. When glazed it will last forever and its lasting qualities will recommend it to the architect. It has a splendid future and I think the period of imitation is only a transitory one, and also that before long the architect will be so educated as to understand that it is truer to have beautiful decorations in terra cotta expressing terra cotta and not something else, than to try to imitate with terra cotta, a stone building.

It will not materially affect you. You will manufacture just as much as you now do and probably a great deal more, but you will do it according to the real principles of art and architecture. That is my belief. I am well aware of what we both have to contend with. I may perhaps, come tomorrow to some of you and say that I want a course of granite (in terra cotta) for my building. If I do so it will be because I am absolutely forced to do it, but if I can have my own way I will not resort to such a substitution and will utterly discourage it. I shall try to educate my clients.

To educate the client is the most difficult task of the architect. You referred to that fact a minute ago when you said you had a client who was very difficult to please. The architect has such clients all the time. An architect recently had to build a house for a man and his wife who was associated with her husband in business. As long as he dealt with the husband, he encountered little difficulty, but when the lady made suggestions he did not know what to do. Finally he had to stop until he made her realize the vital difference between her work and his and that she must recognize his architectural qualifications and not interfere with the work.

May I give you one other example, a personal one? Not long ago one

of my university confrères, a member of another department of the university faculty, came to see me about a house he wanted to build. He inquired about the architect's fee on small houses. You know that the architect gets practically no fee at all when he gets 6% on a structure costing only a few thousand dollars, as the cost of drawings and other expenses consume it all. He can not afford to deal with very small problems in an unprofitable way. My friend did not seem to be pleased with the fee mentioned so he notified me several weeks later that he had discovered a carpenter who knew how to read blue prints and was going to design and erect the building. There is little hope with clients of this type.

MR. SHEFFIELD:—I think our trouble arises from the point of view. The material must have some color. If we make it white, they say it is calcimine texture; we can not use all colors of the rainbow, but must have some color. Instead of matching granite we have given our samples a mottled effect that was never seen in granite and could not be had in granite. We did this in order to get away from this so-called "bath room architecture." We have found since, that architects have responded. We have been asked very seldom to imitate granite; instead, the architect will ask for a mottled combination that will harmonize with my building. The samples that we had were made for that very purpose, and we deplore very much that the architect himself named the material "granite terra cotta," as we never used the term. We speak of mottled surface.

PROF. FERRAND:—That is much better. I dislike to give any name to it and above all to call it by a name not intended for it.

MR. SHEFFIELD:—It is not so much a matter of color, or the shape of the block as it is the imagination of the architect. If he would design clay and think of it as clay, it would not make much difference about the color or shape or size of the block.

PROF. FERRAND:—You full well know you can not use clay as you use any other material. It is something entirely different, physically, chemically, structurally. It possesses a plasticity which none of the other materials have. It can be colored at will whereas this is undesirable with granite, stone or marble, which do not lend themselves to it. You have to back clay, and you do not have to back stone. A stone may be taken out of the quarry and be put into the building. It is a structural element, while clay calls for some backing and you can therefore see how it may interfere with the design. Moreover, there is the shrinkage. Of course, you may account for it, but in certain cases it is difficult and materially impossible to obtain two pieces that will match absolutely. There are always some discrepancies in line, either horizontally or vertically. You can not entirely remedy that and the wise architect knows he must not expect with terra cotta that horizontal or vertical line absolutely perfect,

which he can get in stone or marble. For instance, you well know that a terra cotta column must either be fluted in order to conceal the joints, or else look like the assembled pieces of a mould rather than the column itself.

It is, therefore, up to the architect to find such uses for terra cotta as will justify these irregularities. It has been done in the past and will again be done in the future. Why should we, therefore, try to make terra cotta play the part of granite, stone or marble? It can not be substituted for any of them because the effect produced will never be identically the same. Let terra cotta be frankly and honestly terra cotta, and granite, stone or marble what they are.

MR. SHEFFIELD:—That is exactly what we think.

PROF. FERRAND:—You can get beautiful effects in plainly colored or in glazed brick. There is no question about it, but you can do that also with square tiles which I like better because they are frankly applied material and not structural material. They suggest a decorative and not a structural element on the wall.

The only terra cotta we really use in our walls as structural elements are bricks and hollow tiles. All the others put on the outside are nothing but tiles of a special shape, if you wish, but tiles attached to the wall. They constitute a veneer and veneer let it be, provided it will not deceitfully imitate another material.

You are obviously not to blame for that imitation. As an architect, I will say the architect is to be blamed. But you can and always should tell him that you can just as well make a square panel as one that suggests some different material. In fact, it will be far superior, because it will be more expressive of its nature and function. In a word, it will be more truthful. That is how you can coöperate with the architect.

I do not mean to say that you have been in the wrong in trying various effects in terra cotta. You are absolutely right and I am satisfied you are only started. Your enterprise is still young and many more effects will be discovered in the future. Is it not wrong though, to continue the use of certain kinds of terra cotta to deceive and make people believe that stone or some other material has been used instead? That is the whole question. I would always rather have a terra cotta front purely expressive of terra cotta than a front which would remind me of stone, because it would be false stone.

MR. SHEFFIELD:—Stone was used, at first, because it was the best material at hand, but if the architect has a better material now with which to express himself, why use stone, because it is the only material used a long time ago.

Stone, a long time ago, was the first material man made an ax of; man made steel, therefore steel was an imitation for that purpose, at one time.

Now it is not. It is mind working on the best material at hand, to express yourself, that makes it the right material, and because stone was cut in a certain height necessary in the construction of buildings is no reason why other material can not be used in the same way without calling them imitations of stone.

Because the artist in ages past used a certain profile on a piece of granite, if I use it on a piece of terra cotta, I am imitating granite. That is the point upon which we can not agree with Prof. Ferrand.

CHAIRMAN RHEAD:—I always find that when three or four classes of people get together, for instance a practical man, a business man, a technical man, and an artist, they each have their own language, and their own ways of expressing themselves, yet, each may mean the same thing. They simply express it in a different way. I think most of you who have talked with Prof. Ferrand have the same idea that he has. I think the whole thing should be debated from a purely decorative point of view, and I think what Prof. Ferrand means to say, and what other architects have already said is that there are possibilities in terra cotta that have not been developed.

Being a member of the Architectural League I know the architects and I know they are intensely interested in the possibilities of terra cotta work. I know, too, that there are men who are willing to go a long way to be able to demonstrate their possibilites.

At the last Architectural League Exposition, a number of architects had designed rooms, buildings and models showing exteriors and interiors, illustrating the possibilities of architectural polychrome treatment. I think that if you were represented at the League each year with some exhibit of that kind, it would be an enormous influence for terra cotta work.

MR. SHEFFIELD:—They have been represented. The Eastern Company spent a great deal of money on it.

MR. HILL:—I do not know when it was, but about three years ago, some of the companies had displays.

MR. GATES:—I think the main possibility of terra cotta is in the use of color in a building, both for interior and outside decorating, using this idea in every room suitable for it, especially kitchens and bath rooms.

THE ORGANIZATION OF A DECORATIVE CERAMIC RESEARCH DEPARTMENT[1]

By Frederick H. Rhead

ABSTRACT

Artistic development has been slow in the clay industries and has not yet arrived at that stage where it can be legitimately considered a functioning organization activity.

A research organization is a business activity and not a purely scientific venture. Therefore, it is incomplete if it concentrates on any one essential branch of the industry to the exclusion of the others. Future business possibilities are obviously the main activities.

A budget should be arranged to cover a definite period and a program to provide for a definite result since research work involves considerable expenditure in labor and equipment.

The typical art pottery organization is described, giving the qualifications of the various plant executives and directing heads. The research program in relation to losses is discussed. The types of losses are classified. The investment required in connection with a typical organization of a stated size is outlined. The development program with the results for the first twelve months and the year's results against the expenditures are summarized. The position occupied by the clay working industries in comparison to other national industries is discussed.

Introduction

The past general attitude of manufacturers towards research in connection with decorated ceramic products has been rather nebulous in character. In the decorative field of ceramic work where the draftsman, designer, decorator, architect, sculptor, modeler, craftsman and practical potter play an important part, there has been no organized effort to investigate commercial possibilities and improve manufacturing conditions.

A few individual manufacturers have realized the necessity of giving some attention to this branch of their business, but for many obvious reasons, artistic development has been very slow in the clay industries, and it certainly has not yet arrived at the stage where it can be legitimately considered as an organized functioning activity.

In the one or two instances where concerns are making serious attempts to develop the possibilities in the commercial fields under discussion, many unfavorable factors which would not be present if the activity was operating on strictly business principles, are constantly retarding rational progress.

Everyone intimately concerned with the production of any class of ceramic product requiring the services of decorative and allied skilled specialists has encountered difficulties of a practical or artistic nature which at best have been so costly and troublesome that nine out of ten attempts to produce have proved unsuccessful from a financial point of view. This has even been so in many cases where the result from an artistic or practical point of view was all that could be desired.

[1] Delivered before the American Chemical Exposition, N. Y. City, Sept. 15, 1922.

The remaining so-called successful activities have survived either because the organization in question possessed a purse long enough to stand the strain, or because of the exceptional executive and practical skill of the individual guiding the activity, and more often because of a combination of these two conditions.

From whatever angle this subject is discussed (and there are many viewpoints) the whole matter filters through to the final and immutable question of dollars and cents, or profit and loss. In the commercial field the activity must yield a profit or it can not continue to exist. The concern in question may have the most desirable assistance and be producing the most creditable ware and yet not be a solid business activity, because the income is not at least equal to the expenditure. Further, an activity which may be earning profit at the present time may not be doing this five years from now.

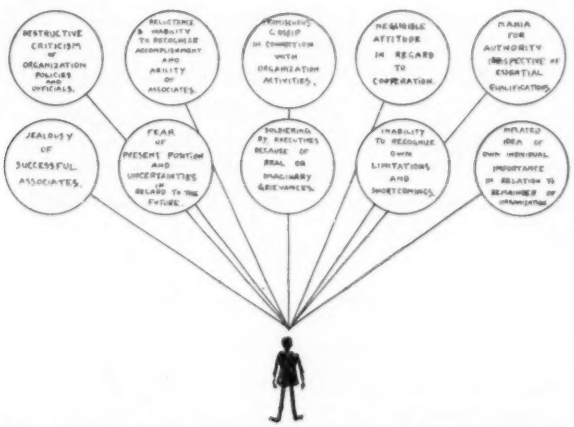

DESTRUCTIVE CRITICISM OF ORGANIZATION POLICIES AND OFFICIALS.
RELUCTANCE & INABILITY TO RECOGNIZE ACCOMPLISHMENT AND ABILITY OF ASSOCIATES.
CONSCIENTIOUS OBJECTOR IN CONNECTION WITH ORGANIZATION ACTIVITIES.
NEGATIVE ATTITUDE IN REGARD TO COOPERATION
MANIA FOR AUTHORITY IRRESPECTIVE OF ESSENTIAL QUALIFICATIONS
JEALOUSY OF SUCCESSFUL ASSOCIATES.
FEAR OF PRESENT POSITION AND UNCERTAINTIES IN REGARD TO THE FUTURE
BROODING BY EXECUTIVES BECAUSE OF REAL OR IMAGINARY GRIEVANCES.
INABILITY TO RECOGNIZE OWN LIMITATIONS AND SHORTCOMINGS.
INFLATED IDEA OF OWN INDIVIDUAL IMPORTANCE IN RELATION TO REMAINDER OF ORGANIZATION

FIG. 1.—Unfavorable mental attitude of plant executive.

In order to have a staple business, the manufacturer must be in a position where he is realizing a fair proportion of the possibilities in his particular line. There are many manufacturers today who are making what they consider a satisfactory profit, but who are not realizing over 10% of the potential market possibilities. This is not a secure business condition. For instance, a certain concern engaged in the manufacture of art specialties has an output of approximately $300,000 a year. But, assuming that these specialties represent less than 20% of the potential market, and that there are at least three domestic and from fifteen to twenty foreign competitors concentrating on the obvious possibilities while a far greater field of potential possibilities in similar lines are untouched, it is easy to see that the manufacturer must give serious attention to the study and development of all allied types. He must do this in order to be in a position to

improve the present product and to extend the line in every direction compatible with materials and conditions at hand. The market for art wares is as illusive as the moving picture or musical comedy market, and infinitely more difficult to gauge, because no serious attempt has been made to properly classify it, or even crudely approximate its value.

It is not the purpose of this paper to attempt to analyze this or any of the various ceramic markets. It is enough to state that the present domestic source of supply is the result of the natural growth of the pioneer activities of forty years ago or thereabouts. With few exceptions, processes and methods of manufacture are unchanged. There is no organization in the advanced sense of the term. Not one plant in a dozen has an adequate cost system, and "research" is confined to such activities as the occasional purchase of some domestic or imported "best seller" in order either to copy it outright, or to make something closely approximating it in general appearance.

In other words, the manufacturer is satisfied to meet the present demand without thinking of or considering the far greater potential market, and planning (as an efficient executive in any other business would do) to create a demand for this market. Of course, under present conditions, it would do him little good if he succeeded in creating a demand, because the great majority of organizations as they exist are entirely incapable of supplying such a market.

The Value of a Research Department

This condition refers us back to the question of organization and the need for an efficiently functioning research department. To attempt to lay down definite laws in regard to the planning of a research department and its relationship to the remainder of the organization would be folly, because the problems involved vary with each concern and according to the personnel of the organization.

It is obvious that there should be a director or some individual responsible for such an activity, but in two or three cases known to the writer, the owner of the concern is personally interested in dabbling in experimental work. In other concerns, the decorative work is in charge of specialists who are clever individual craftsmen, but who have no executive ability, and who are entirely unable to direct anything larger than a one-room activity. Many of these men will not teach others the fundamentals of the practical work, fearing that such an attitude would be harmful to themselves. A third condition relates to the type of organization. In some places, the development work is in the hands of the ceramic engineer, who in the large majority of cases possesses about as much executive and business ability as a peanut vender.

Unless the concern interested in progressive development is large, and the officials responsible for the factory policy are solidly back of such an undertaking as an up-to-date research department, the three conditions mentioned will be found inimical to any addition to the present old fashioned and imperfectly coördinated type of organization.

But as such an addition as a research department is already recognized as one of the most vital essentials in connection with modern plant organization, no amount of selfish or ignorant individual opposition can succeed in obstructing the organizing and efficient functioning of such a department, especially if it is in the hands of a man who understands artistic, practical and technical standards, world markets, sources of supply and who has the ability to direct factory operations.

Plans for the Research Department

In outlining a decorative research department, the writer must base this upon some particular type of existing organization, or he must assume that the undertaking is entirely a new one. In the latter case, it is a comparatively simple matter to submit a program, because the research activity would naturally take its place in the initial organization. But in the

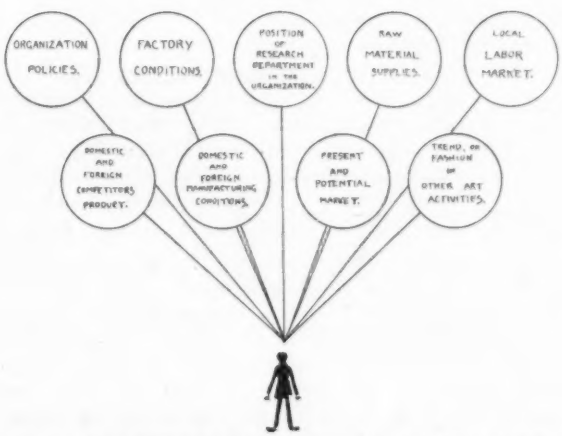

ORGANIZATION POLICIES.
FACTORY CONDITIONS.
POSITION OF RESEARCH DEPARTMENT IN THE ORGANIZATION.
RAW MATERIAL SUPPLIES.
LOCAL LABOR MARKET.
DOMESTIC AND FOREIGN COMPETITORS PRODUCT.
DOMESTIC AND FOREIGN MANUFACTURING CONDITIONS.
PRESENT AND POTENTIAL MARKET.
TREND OF FASHION IN OTHER ART ACTIVITIES.

FIG. 2.—The Research Director must be familiar with the above activities and conditions.

former, the activity would have to be planned in such a manner that it would commence as an independent department and then gradually be absorbed and tied into the factory organization without interfering with the present shop practice or existing personnel.

For the purpose of this discussion, we will assume that the officials of an art ware plant doing the business of the size previously mentioned have

decided to adopt a policy covering greater development facilities, and to include in the present organization a properly equipped research department. A survey of the conditions within this organization will approximately result in the following facts:

1. Size of Business and General Operating Expense:

Paid in capital	$100,000	
Output approximately	300,000	
Material	60,000	
Direct labor	80,000	
Manufacturing expense	100,000	
Selling and administrative expense	24,000	
Total income		$300,000
Total expenditures		264,000
Net profit		36,000

2. Ownership.—Family corporation.

3. Management.—The president and general manager is the founder of the business which is over thirty years old. He was formerly an insurance man. Possesses good general business knowledge. Is a capable

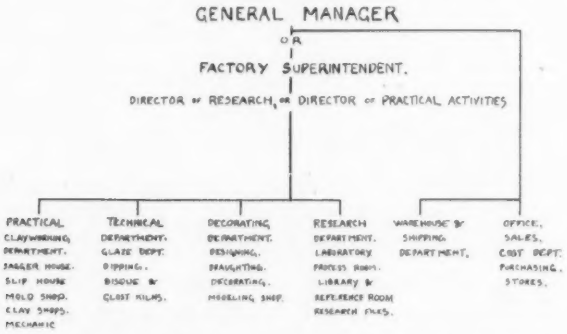


FIG. 3.—Chart showing type of organization that has proved successful.

executive and interested in possibilities of development, a good judge of standards, and well acquainted with the local conditions. Not so well acquainted with the artistic and technical side of the work, but capable of judging results. He is rather skeptical in regard to technical and artistic executives, because he has experienced a number of rather costly experiments in connection with this class of help.

4. Organization, General Manager.—The general manager practically directs the entire factory operations, and about all the routine details are brought to his attention. He spends little time in the plant, and the heads of the various departments consult him individually in connection

with their own particular activity. There is practically no coördination (as understood in modern plant practice). Each department head looks after the interests of his own department fairly efficiently, but has little or no interest in production outside his own department. The various heads have no official title, and there are no group conferences or consultations in connection with factory activities.

(*a*) **Factory Engineer.**—A good construction man. In charge of power, heating, lighting, machinery, plumbing, repairs, carpenter shop, etc. Unusual repairs or new construction is referred to the general manager. Otherwise, the engineer acts on the request of the various department heads. He is pretty much of a czar in his own department, and the other officials are likely to experience delays in getting essential work done if they should be "in bad" or happen to "cross" him in any way.

(*b*) **Head, Clay Shop.**—A fair practical potter, according to local standards which are not high; no technical education; will force production at the expense of good potting with the result that the loss in the clay shop is much higher than it should be. Will act only in regard to better quality when complaints come in from customers. Is not susceptible to new ideas and changes in method. Is not particularly friendly to the other officials and resents suggestions or comments from them in connection with standards.

(*c*) **Kiln Boss.**—In charge of a former kiln placer who has been broken in by a former kiln fireman. Very reliable and willing. Not an experienced fireman. Fires to cones and draw tiles. There is no pyrometer equipment. So far as can be ascertained, no actual records are kept. Glost kiln losses average approximately 30%, but this is not consistent. Some kilns will show from 80% to 90% acceptable production, while others will be 50% or even less. Four or five different types of glazes requiring different kiln treatments are in general use, and the kiln position for each glaze is constantly changed. No standard practice or scientific method of control as understood today. There are no firing charts for references or record purposes. The sagger losses are particularly heavy. Fifty per cent do not survive the third or fourth firing in the glost kiln.

(*d*) **Head, Glaze Department.**—This man is a graduate of one of the best technical schools. No previous practical experience. Possesses the qualifications of a capable and efficient ceramic engineer. About all of the technical problems are turned over to him. He gives some attention to body and glaze control and generally arranges the kiln positions for the various products, but he has no defined authority either in the clay shop or the kiln shed. He is not a practical potter in any sense, and has no understanding or appreciation of art or decoration. While he is capable of formulating glazes which are technically good, because of his lack of art training or feeling, he is entirely incapable of judging color values or textures. In other words, he will develop glazes which may have technical interest, but which have no artistic value to the trade, while he will reject colors and textures which would be highly acceptable. Although he has had no practical experience in plant operation, he is more interested in the executive work, as he understands it, than in the technical work he was trained for. Because of this failing, he is constantly interfering with the other activities and assuming authority which he does not possess. He has absorbed the modern technical school philosophy which instills in the mind of the technical student that he is the only highly trained specialist in the ceramic industry, and which also suggests that this class of training especially fits him to boss the job. He has somewhat of a contempt for the practical potter, because the great majority of the practical men have had no technical school

training, and because they can not discuss factory problems in technical language. It is his conviction that all artists and decorators are cranks, and at best, a high grade of skilled labor.

(*e*) **Head, Decorating Department.**—A former decorator who has had a few drawing and painting lessons under a local art teacher. One of the many unfortunates who are born "with a talent for art" and who are drawn to any local industry using the services of a decorator or draftsman. He is able to apply elementary decorative forms in a workmanlike manner, and knows two or three decorative processes. He uses mechanical devices to cover his inability to draw easily and quickly. He has absolutely no art training as judged by European art school standards, and consequently possesses no knowledge of historical ornament ceramic shape construction, or the technique of the painter, etcher, sculptor, or craftsman. His stock-in-trade is his practical experience in the two or three simple decorative processes in current practice. He is not in any sense a designer or originator. His idea of a "new line" is an adaptation of a popular line of some competitor, or in extreme cases, a gross plagiarization of some historical type. There is no attempt to study the market or to try to raise the standard of commercial art work by working out new developments. When it is necessary to get out a new line, he is so saturated with the knowledge of a successful competing product that he can neither analyze the cause for its success nor produce a type that is not based upon this particular "best seller." Consequently while the resulting product from a practical and technical point of view compares favorably with competitive wares, and while it is commercially acceptable to a certain class of department store trade, its market is limited by its own artistic shortcomings. He does not realize that there is a large purchasing public who will not buy pottery that is obviously badly designed and unskillfully executed. The high schools, universities, fashion magazines like *Vogue*, *Vanity Fair*, and the *House Beautiful*, and even the moving picture industry have ingrained into the younger generation a conception of art standards, that while limited in scope, is high enough to be able to recognize acceptable conventions to the rejection of what is considered as either old-fashioned or in bad taste. In short, our decorator under discussion and, unfortunately, the average ceramic decorator is not educated up to the standard of the average high school student or prospective pottery purchaser.

(*f*) **Head, Shipping Department.**—A most efficient and hustling executive. While most of the product is sold from stock, he is very careful not to over or under stock. When special orders are being made, he will keep in touch with various departments and assist in routing the product through to the shipping room. He is a good judge of standards and is very quick to report any tendency such as shop carelessness or deviation from a fixed standard. He is the one executive who is on friendly terms with all the other heads of departments, and in an unofficial way does more in the way of general supervision than any other person in the plant.

(*g*) **Office Manager.**—This man grew up with the business and has acquired all the faults and few of the qualities of the "old and faithful servant." As one of the oldest employees, he expects all the reverence and respect due to an antique, but unfortunately his "patina" is the result of disuse and age. He gives scrupulous attention to those matters which come to the attention of the general manager, who accordingly is favorably inclined toward him. He is naturally careless in his correspondence and treats all dealers as his natural enemies. He is a difficult proposition when handling claims and complaints. The dealer is always in the wrong and the factory always right. His attitude toward the salesmen is distinctly unfriendly, and his lack of coöperation often causes serious dissatisfaction among customers. He can not understand why standard lines of ten or fifteen years ago are not still popular, but believes it is because the buyers are distracted by too many new products.

Summary of Organization.—It will be seen from the given description of the organization that the general manager is also factory superintendent and director of department activities. In addition to his legitimate duties in connection with financing the undertaking and handling the business and sales, he is not only burdened with the multitudinous practical details that come up daily, but because there is no other directing factory head, he is the active force in each individual department. Under such circumstances, results are limited not only by lack of organization, but by the limitations of each individual in charge of a department. If the general manager personally can not supply an essential quality lacking in one of his executives, the results fail accordingly. There is no question that this particular organization (if it can be called such) is seriously lacking in a number of important essentials, and that the manager is handicapped to such an extent, that it would be a mental and physical impossibility to manufacture products with anything like a possible efficiency demanded in almost any other industry.

Development of Commercial Art Pottery

General History.—When the plant was organized over thirty years ago, the product consisted of a single line of crudely and atrociously designed flower pots glazed after the manner of the so-called English "majolica" ware.

This was the standard commercial art pottery for a number of years. About 1880 a well-known pioneer art pottery produced a line of slip-painted vases after the style of the French Barbotine process, but painted and glazed in rich yellows and brown tones. A demand was created for such a ware so that the originators were entirely unequipped to supply or perhaps they did not realize the commercial possibility.

However, the concern under discussion did see this possibility, and then proceeded to manufacture a similar product. The venture was so successful that other art potters followed suit, and the process and decorations were widely and vilely copied. The original concern making this ware then produced vases and other wares based on the type made by Royal Copenhagen and similar concerns. The decorations were still naturalistic, but were painted on light grounds in pastel-like colors, while white glazes were used instead of the rich iron yellow glaze. The various commercial art potters again followed suit, and tons of this product were put on the market.

About this time, mat or vellum glazes began to be used, and while the pioneer art pottery mentioned was dabbling in this type of glaze, the commercial potters immediately grabbed this possibility, and if the resulting product had at all been acceptable to a cultivated taste, they would have flooded the earth with it. As it was, millions of pieces were put on the market and sold.

The Paris Exposition of 1900 was the happy hunting ground for ceramic manufacturers looking for "inspiration." Most of the big European pottery manufacturers and scores of individual studio potters exhibited, and on no occasion before or since has there been on display such a comprehensive variety of decorative processes and ceramic ware.

This period might be classed as the beginning of the commercial art and craft movement. The American potters were not slow in responding to the impetus given to commercial art pottery possibilities, and while at that time they did not possess the skilled help necessary for the production of such types, many foreign craftsmen came to this country to connect with the American concerns.

Unfortunately, the American manufacturers did not understand the European conditions, and because of this, they quickly engaged any foreigner who applied for a job and gave him privileges out of all proportion to those he would enjoy at home, where he was subject to strict supervision by a capable director and not allowed to experiment or dabble without a defined program. Although there were good results here and there, a condition developed where these foreign specialists (merely bench decorators in their own country) fearing that their "secret processes" would be taken from them, insisted on working behind closed doors. At the best, they refused to teach others the various processes, and to enter their formulas and processes as part of the factory records. This attitude resulted in one-man activities, obviously limiting the production and commercial possibility in connection with their particular process. In some factories there would be ten or a dozen such specialists working independently and fiercely antagonistic toward each other.

A few of the manufacturers objecting to the constant distraction, the limited output and consequent high overhead, simply appropriated what they could of these processes and attempted to make a factory activity of the product. But as most of the foreigners were men who were not particularly expert decorators in their own country, no important development followed, although this foreign element did exert influence at a time when domestic ceramic decorators were an unknown quantity. But while there were scores of different "lines," and an endless series of varied decorations, the actual processes, factory methods and standards remained practically unchanged, with the exception of two or three art potteries whose output was so small as not to be properly classed as commercial products.

The Market Today

The bulk of American art pottery is beneath acceptable artistic standards. It is not found in company with good books, prints, furniture and rugs or in the possession of individuals who buy Wedgwood, Worcester, Copenhagen, Doulton, Minton, Rookwood, Lennox, Rozenberg, Dresden,

Limoges, Copeland, Rorstrand and the best of the European and Asiatic craft potters.

Its market ranges anywhere from the premium-giving tea and coffee dealers to the middle-class trade of the department stores, and represents, roughly speaking, about 30% of the art pottery buying public, and from 10% to 15% of the actual value of such products sold.

Consequently, if this estimate is at all approximate, there is an untouched market of 70% of the present buying public, and a value of from 85% to 90% over the present output. And this does not refer to the potential market that is being created by the constantly increasing standards of living, and the rapidly growing interest in art activities.

Present Production.—The line consists of vases and art specialties and is broadly divided into two groups: vases, bric-a-brac and various ornamental specialties, table ornaments, candle sticks, match safes, flower bowls, etc., and the large jardinières, pedestals and umbrella stands. A classification of the various types is about as follows:

Old colored glaze line	5%
Slip decorated, Rookwood type	7%
Slip decorated wares, Copenhagen type	20%
Plain mat glazed product	25%
Modeled specialties	25%
Monochromes or plain colored enamels	15%
Individual decorated wares	3%

About 65% of this product is made in a buff body, and the remainder in a cream colored earthenware. The bisque is fired to about cone 3 and glazed to about cone 01–1.

Research Program

In considering the extent of a practical research department it is obvious that this must be planned in harmony with the present financial and practical resources, and in the first period without a noticeable increase in the overhead. But as an efficiently functioning research department is not a one-man activity, but an organization proposition, the mere engaging of a capable research man does not provide the solution to the problem. It will be remembered that the concern under discussion is doing a business of $300,000 a year and showing a profit of about $36,000. On the other hand, the losses are averaging 30% of the output, which would figure at something over $125,000 sales value. If by increased efficiency, these losses are reduced to within 15% during the first year, this would increase the revenues $62,500. These savings refer only to kiln losses and not losses due to waste and general factory inefficiencies.[1]

[1] With 30% loss, $300,000 equals 70% of the total production which with no loss (an impossible accomplishment) would bring the income up to about $425,000.

Any efficiency engineer who has visited the average art pottery can quickly prove that the plant operations are at best not more than 60% efficient, and the concern under discussion is probably less than 50% efficient rather than higher.

If this standard of efficiency were raised 10% a year for five years (an ordinary accomplishment) the research activity would easily have paid for itself, while the kiln losses would be reduced and production increased without an appreciable difference in the general expenses.

Such results could only be brought about when the research director is given authority to make necessary adjustments, but the general manager has acquired the habit of handling the factory routine, and it is not easy for him to relinquish this. Furthermore, the factory officials have been brought up to the present method of transacting business, and the manager is afraid that they would actively resent the authority of an outsider, a not ungrounded fear.

But if it were possible to do this, the investment connected with the undertaking would consist of the salary of the director plus office furniture, filing cabinets, book-cases, experimental studios, room for filing research specimens, and what special apparatus might be needed. The director would submit his program based upon the obvious present needs and would proceed to coördinate and organize with a minimum of interference and interruption with factory production.

This would be the procedure adopted in almost any other industry. But as stated, modern business practice is yet the exception in the ceramic industry, and it is a question if a manufacturer could be found who would be far-sighted enough to do the rational thing, and, curiously enough to the business mind, the obvious thing. Consequently, the director must bore from without, and proceed by building an organization which will gradually be absorbed by the various departments. This latter method is a more expensive operation, and it takes longer to get results, but this fact should be admitted and should not be charged against the research department, (although it will be). However, conditions are such that the director of research is to commence activities by the latter method.

Before we formulate the program, and outline the results to be attained within a definite period, we must consider the maximum cost involved. The director can not act without spending the firm's money, and he can not act intelligently unless he knows the extent of his budget and its application. He also must be in a position to show the general manager at any time just what is accomplished, and at what cost.

Too many specialists have a negative interest in the organization as a whole. They are wrapped up in their particular activity to the exclusion of allied or connected branches. They also assume the rôle of employee with its too often accompanying feeling of uncertainty in regard to the

future. Very definitely they do not regard themselves as organization men and as much a part of the concern as the kilns are a part of the building. They order material and equipment, and plan without full consideration of the money involved, or the expected result from a purely financial point of view. It is contended here, that the successful research man must know what his expenditures are, and that he must check these with ensuing results on a financial basis, and not on a purely intangible basis of assumed accomplishment.

With these ideas in mind, we will assume that a man of exceptional ability is in charge, and that he is to be paid ten thousand dollars a year. It is understood that he is sent to important technical, artistic and business conventions, involving an annual expense of about one thousand dollars. Assuming that the necessary fixtures, furnishings and special equipment cost five thousand dollars (a maximum amount for the first year) and with factory expense in connection with material, labor and operating expenses totaling another five thousand dollars, we find that the concern must provide for an expenditure of something like twenty-one thousand dollars for the first year, or approximately seventeen hundred and fifty dollars a month. What results can be expected from a *practical* and *financial* point of view within the first year to justify a continuance and further development of such a department?

Regardless of the program in connection with new developments, there are, in every ceramic plant, many bad conditions which are not corrected simply because there is no one concentrating on these conditions. The average organization is so used to shop and kiln losses that these are accepted as inevitable, and only to be noticed in exceptional instances or when there is constant complaint from customers.

A 20% loss causes no particular concern, and a product bearing a 50% loss or more is considered as a difficult technical or practical proposition, which is solved by putting the product in a "special" class at a price high enough to cover the increased loss. The average man in charge of operations is a specialist of the most limited type, and he will, more often than not, hesitate to admit his ignorance or limitations in connection with the shop trouble, which will often continue for years when a few words from a competent source might immediately adjust this difficulty and save the concern a considerable sum of money.

Art Pottery Losses

In an art pottery, the art director is, or should be, the best judge of standards, and if he is a practical potter, which should be one of his chief qualifications, he is the man to be responsible for the correction of all faults affecting the quality and standard of the product. Many of these faults

may not be obvious to the person who is not trained in art matters and consequently not noticeable to the various officials or even to the trade. But they are noticeable to the trained eye, and because they do affect the quality of the product, steps should be taken to improve the standard of workmanship so far as the acceptable cost of production will allow. Factory losses in art potteries are of three general types:

(*a*) **The Use of Unreliable Body and Glaze Compositions.**—Lack of standards for raw materials. Of imperfectly standardized bodies and glazes. Glazes that are too sensitive for present kiln conditions. Variations in material grinding.

(*b*) **Inefficient Shop Practices.**—Lack of system. Poor drying facilities. Poorly organized mold shop. Faulty mold construction. Poorly designed shapes from a practical point of view. Inadequate supervision in the slip house, sagger house, clay shop, and studios. Dirty and poorly arranged work rooms.

(*c*) **Incompetent and Careless Workmanship.**—Inadequate supervision in connection with the various processes.

It is an unquestioned fact that the mere presence of an interested, capable authority on standards in a clay working plant would result in the material reduction of losses with an effort and expenditure of time which would not seriously interfere with his work in connection with new developments.

Acting in the capacity of a coach, he would quickly correct faults which were almost inevitable without such direction, and which would save the concern two or three times the salary in his first year in regard to actual losses. This would result in increased production of a higher standard. A 10% increase in shop efficiency would net the concern $30,000, while a decrease in losses would be a saving in proportion. Some opinions may say that these two conditions can not be taken separately, but it is certainly definite that a mere reduction of the kiln loss will not make the acceptable product higher in quality or artistic value, nor will it mean that many shop inefficiencies will be eliminated. The present production would be increased, because there would be less kiln loss. But if the present production is only 60% efficient, the kiln losses have no relation to this condition, nor would a decrease in sagger losses affect the quality of production. There are opportunities to reduce both the kiln losses and to increase present production by adjusting or eliminating unfavorable conditions.

Value of Research Head

Whether the research head would be allowed to give practical attention to these matters is probably questionable. There are many deeply rooted prejudices in the ceramic industry, and not the least of these refers to anything that suggests departure from current shop practice. These prejudices are more pronounced in localized ceramic industries. But assuming that the research man had no authority to change unfavorable conditions, and that he was operating an entirely independent activity,

the fact that he was actively engaged in the plant would be a noticeable influence among those executives who were at all interested in increased efficiency. His work would be closely watched, and notwithstanding the jealousies and criticisms that are ever present in such organizations, the various specialists would consciously or unconsciously exert themselves to a greater effort.

While such results are intangible and due to the presence of the director rather than to his personal accomplishment, whatever results he is known to have attained will also affect the mental attitude of the men responsible for factory production, even if they are not brought into direct contact with the research department. I know of instances where a research man, although working independently of the remainder of the organization, has changed the entire character of process and style of decoration.

In some cases, the different specialists wanted to show that they could do the same things. In others, they wanted to acquire additional experience. But whatever the reason and however detached his activities so far as official action is concerned, the director is, if he is a productive man, a definite force that can not or will not be ignored.

We shall assume that these ideas are accepted, but we shall not reckon such intangible benefits in connection with the investment involved. We shall include only the actual and independent productive results. In recording these activities, we shall divide the year into twelve monthly periods, itemizing the results with the approximate costs and resulting business. For obvious reasons, we are not describing actual processes or giving detailed information in regard to historical types to be used. These are individual problems and will vary with the particular concern and its present market. Assuming that the activities commenced at the first of the year, the results are recorded as follows:

The work is divided into two groups: (A) Organization Work, (B) Productive Work.

First Month

(A. Organization Work)

1. Installation of equipment: Director's office, files, typewriter, desk, drawing cabinet, book cases, cases for factory museum samples, room for record samples, glaze laboratory, modeling room, decorating room, casting room, camera, microscope, etc.

2. Survey of present factory conditions, description of product, and report on present market.

3. Detailed program of activities for the first three months.

4. Planning and printing the research records, formula cards, decorative process cards, shape number cards, cards for factory numbers, files for stencils, estimate blanks, arrangement of filing system, labor and cost records.

(B. Productive Work)

5. Series of fifty sketch drawings showing types of wares to be produced.

6. Working drawings of twelve shapes selected from above sketch drawings.

7. Preparation of three bodies and twenty glazes to be used in connection with these products.

8. Production of models and molds for above twelve shapes.

9. The casting and jiggering of twelve of each of the above shapes (this can be done by the director personally, or the molds can be turned over to the clay shop foreman, who fills in a research cost card showing amount of time and material consumed), but the pieces must be made according to instructions. These sample wares are made from the original molds. No blocks and cases are made for the original test series.

10. Decoration and glazing of the above shapes.

11. The first series of glaze tests and finished decorative samples go to the kiln.

NOTE:—If this seems an unusual or unreasonably large amount of work to be accomplished in the first month, it might be well to state that these notes are taken from a diary recording actual work accomplished in this space of time. However, it must be understood that not every decorative specialist understands modeling, mold making, or even glaze preparation. In such cases, it is obvious that these activities could be carried out in the factory modeling and clay working shops, and charged to the research activities. But because of the standards and new processes involved, it is highly desirable that the director be a man who is capable of executing all the processes under discussion. The fact that he does this helps to determine the standard to be attained.

SECOND MONTH

(B. Productive Work)

1. Further series of ten or twelve working drawings.

2. One week for American Ceramic Society Annual Meeting with side trip to New York to show designs to dealers, and to investigate present and future market conditions in connection with present program.

3. First decorated pieces out of glaze kiln. Conference with general manager to decide modifications and adjustments. These sample wares are numbered and filed for immediate and future reference.

4. Production of models and molds of second series of working drawings.

5. Further series of about one dozen each of new shapes cast or jiggered from original molds.

6. Decoration and glazing of above shapes.

7. Received first series of glaze tests from kiln. Reviewed and recorded results. Formulated second series making necessary adjustments and modifications. Commenced to standardize a palette of colors in connection with three types of glaze suitable for present needs.

THIRD MONTH

(B. Production Work)

1. A second series of completed decorated and glazed samples from kilns. Selected types considered most suitable for present market. Filed successful rejected samples for future reference while holding selected examples for immediate use.

(A. Organization Work)

2. Conferences with general manager and factory salesmen in connection with selected examples which are compared with present product and competitive lines. Costs and factory conditions discussed.

3. Visit to two or three important customers in connection with above selected lines. Report for the general manager on the result of this trip.

4. Samples are coming from about every glost kiln. Each variety and type appropriately classified, numbered, and entered into the process records.

5. Completion of first series of standardized glazes and bodies. Samples numbered and filed, and glazes entered according to their respective types and temperature range.

6. Completion of series of approximately four hundred sample pieces in plain glazes and decorations.

7. Commenced to produce first decorative lines for market. These lines will include new shapes and decorations appropriate for present market with four or five special shapes to broaden various lines. The types will be about as follows:

(A) Commercial or cheaper grades of plain glazed wares.
(B) Selected or middle grade plain glazed wares.
(C) Commercial decorated wares.
(D) Selected decorated wares.
(E) High class special products.

Résumé of First Three Months' Work

1. Productive results. Developed a series of three types of glazes each in eight colors with three shades of each color.

2. Produced the following series of art ware samples:

Type A	100 pieces
Type B	100 pieces
Type C	75 pieces
Type D	75 pieces
Type E	50 pieces

making total of four hundred samples.

3. Completed series of working drawings of shapes based upon selected samples, and to be used for new lines for factory production.

4. Research results. Filed research reports giving formula and description of process, method of manufacture, type of labor involved, and itemized estimate of direct and indirect labor and material cost in series of 500, 1000, 5000, and 10,000 pieces of each item.

Costs in Connection with Above Activities.—The three months program has cost approximately $5500, $2500 being the director's salary, and $3000 being the proportionate expense for equipment and factory expense for the three months.

Application of These Results to the Research Program.—(1) The three standardized types of glazes are being used in connection with current developments; (2) the new line s of the various types have been selected from the completed samples to date; (3) the working drawings are being released for modeling and for the production of actual sales samples; (4) based upon the research cost and production reports of the particular samples, the sales prices for the various lines are being made. The sales campaign is also being planned.

The General Manager's Summary of What Has Been Accomplished for Expenditure Involved.—1. He has at his disposal a standardized series of new glazes for future production and has adopted a system which will permit of definite glaze control both in regard to color and texture.

2. He has formed the nucleus of a collection of classified research samples for reference purposes in connection with shape, construction and design.

3. He has adopted a system permitting central control in connection with the production of new lines.

4. He has formed the nucleus of a library of research reports for reference purposes in connection with the technical, practical, artistic and cost problems constantly arising in the plant, and the marketing problems in connection with sales policies.

5. Because of the above four activities, he is in a better position to define the factory policies, and to direct and control the activities in both the research department and the plant without being dependent on the idiosyncrasies of art specialists or any one element of specialized labor. In other words, the system outlined will make development work an organization activity instead of placing it in the hands of four or five individuals whose activities are not properly coördinated.

Fourth Month

With the commencement of the production of the actual samples, the research activity should begin to tie up with the factory organization to the extent that the latter provide facilities for the partial or entire execution of the samples, for instance about 65% of the total production is in class

A and C. Attention will be given to these two types first, and arrangements made to have such samples produced by the regular factory help. A research order O.K.'d by the director or general manager accompanies each lot of samples to be made, provides for the recording of labor, material, decorating, firing and other costs allowing for percentage loss. The resulting figures will both assist in making the sales price, and also give the costs to be charged against the research department.

In almost every plant, there are workmen who take care of the special work in their respective departments. Such men can very well be entrusted to assist in making the samples and in paving the way to factory production. But while a director possesses no official authority either in the clay shop or studios or over the special labor involved, he is responsible for the successful production of the samples, and should give instructions both in regard to methods and processes and be in close personal touch with those engaged in this particular work.

With such a program in mind, the director can then concentrate for a period on the production of models and the glazing and decorating of the cast and jiggered samples, leaving the blocking and casing, casting and jiggering, glaze making and firing to the respective factory departments. Assuming that he makes an average of three models per week, and that the present line is to consist of twelve models in each type (A and C) allowing for the time taken in decorating and glazing the various models as they are molded and cast, we find we have a sixty days' modeling program for the two lines.

But as a completed model is immediately sent into the mold shop, it is only a matter of a week to ten days before clay samples would be made, and a further period of from twelve to fifteen days before the sales samples begin to come from the kiln. With the general program planned as suggested, the trade would be already familiar with the type of work being produced, and a condition created where the samples could be presented to the trade and orders taken without a longer period of delay.

In the art ware business there are many standardized articles that find an immediate market, and it is such items that should receive the early attention of the research man. With these facts accepted, we find that it is possible to present sales samples of two different lines to the trade within the fourth month of the activity, or certainly within the fifth month, if it is found advisable to ship directly from stock. But under no circumstances should stock be made of products that have not been shown to the trade, or which have not met with definite approval from more than one prominent dealer. It should be realized that the dealer is just as much a part of the organization as the man who is producing the goods. With such coöperation there is no doubt whatever that a well designed and finished product will enjoy an immediate market.

Activities

1. Completion of fifty pieces of each line (A and C).

2. Wares carefully examined and standards of workmanship are adopted. (Those concerned with the production are informed in regard to acceptable maximum and minimum variation in size, color, and general finish. When the actual production commences, those in charge of each process are shown actual acceptable and non-acceptable examples. Such examples are kept on file for reference purposes to be used when there is a question of variation of standard. No one concerned with the practical work is left in doubt in regard to the various essentials necessary to the production of satisfactory wares).

3. Manufacturing costs, manufacturing expense, sales and administrative expense and wholesale selling prices are determined. (The expected percentage loss is carefully figured and reckoned with in determining the manufacturing cost.) If there is a market for seconds, these can be allowed to accumulate and turned into cash at various periods. Assuming that 90% of a product is satisfactory, this leaves 10% to figure either as a total loss or to be partially recovered when seconds are sold. If half of this 10% is clay, bisque, or glost kiln loss, this leaves 5% of product to be sold at 50% of the regular wholesale value. This means that $20,000 of ware (sales value) with a 10% loss only nets $18,000. But if 5% realized $500 or half the net wholesale price for perfect ware, there would only be a $1500 loss instead of $2000. This $500 would cover the actual loss incurred, because deducting the 12% profit and the 30% sales and administrative expense, the actual cost of producing this $20,000 of ware would be $11,600 and the 10% loss would figure at $840. A 5% recovery on the sale of seconds would be $500, which would be seen to be an actual money loss of $400 in labor and material to be added to cost of production.

4. The line is released for the market.

5. Modeled twelve shapes for line B.

6. Glazed, cast and jiggered fifty samples of each of the above type.

7. Research reports, process records and observations in connection with the production of the samples.

Fifth Month

1. Line B from kiln assembled and recorded as was done when lines A and C came from the kiln. Standards and costs recorded as in activities 2 and 3. (Fourth Month.)

2. Ware released for the market.

3. Preparations for orders for lines A and C. Mold making, casting, decorating, kiln, stock and shipping facilities arranged.

4. Records and research reports as before.

Sixth Month

1. Received and commenced to manufacture first orders on lines A and C. (The production is watched very closely so unexpected and unfavorable developments can be promptly adjusted.

While this is now entirely a factory activity, the research director is working in close coöperation with the factory officials concerned with this production. The various standards in connection with any involved weight, thickness of piece, finish, period of drying, temperature of bisque, thickness of glaze, glost kiln treatment, all of which have already been decided upon, are modified or adjusted to suit the condition of quantity production. Any change is immediately recorded and noted on the process cards.)

2. Modeled the twelve shapes in line D.
3. Cast and jiggered fifty pieces of each shape.
4. Recorded and filed necessary reports in connection with practical operations and the various elements pertaining to production.

Seventh Month

1. Amount of factory production on first orders $2500.
2. Modification and practical adjustments in connection with the new factory production.
3. Further samples and developments as a result of observations of the results of the new production in comparison with original samples.
4. Four new models in accordance with the above.
5. Filed reports, cost estimates, new process records, etc.
6. Further series of glaze tests for standard colors not in present line.
7. Worked out a labor and production program based on sales and factory production of approximately $50,000 for the remaining five months of the first year period of this research experiment.

Eighth Month

1. Production: $4000.
2. Same activities as in seventh month.

Ninth Month

1. Production: $6500.
2. Ten day trip to Chemical Exposition, New York, and visits to dealers who had received shipments on new products.
3. Reports to the general manager on above trip. The reports covered the following activities: A. Chemical Exposition. B. Dealers' opinion on new lines and their reception by the public. C. Recommendations and suggestions.

4. Adjustments and modifications in connection with the new factory product.
5. Production of research samples modeled last month.
6. Two new models based upon recommendations of dealers in accordance with report C (this section).
7. Filed necessary reports and factory data.

Tenth Month

1. Production: $9000.
2. Commenced work on one dozen new models for next year's line.
3. Filed and recorded necessary reports.

Eleventh Month

1. Production: $12,500.
2. Completed twelve models.
3. Glazed and decorated sales samples of new models.
4. Recorded and filed necessary reports.

Twelfth Month

1. Production: $15,500.
2. Series of sales samples of new line from kiln.
3. Conferences in connection with next year's program. Decided on actual work to be done.
4. Annual report covering the twelve months' activity and suggesting necessary plans for the coming year.

It will be seen that in addition, the regular business (which should not at this time be affected by the introduction of new lines) has been increased to the extent of $50,000. All the costs pertaining to the production of stock and orders on these lines would properly be charged to factory expense, but costs pertaining to research samples and the development of the lines are charged to the research department. But the research department is credited with the increase in business and prestige resulting from the success of these products. In summarizing results for the year, we find that the director has been responsible for the following activities:

1. The development of three new types of glaze.
2. The production of 500 research samples.
3. The production of five new lines of art products for the present market.
4. The direction of the production of orders on new lines totaling to $50,000.
5. The production of one new line of art products for the coming year.
6. The organization of a system for the development and produc-

tion of art pottery which fully perfected will operate with a minimum of loss and expense and with a greater efficiency in operation.

The costs involved for the given twelve months' activity would be distributed about as follows:

Total expenditure	$21,000
Equipment	5,000
Research and development including new glazes, sketch designs, working drawings, research samples, business trips and reports	5,500
Production of sales samples	7,000
Supervision of production	3,500

which means that $10,500 will be charged to factory production in addition to the regular factory expense involved in the production of orders on the new lines, and $5,500 for research and development.

Maintaining the same ratio of profit as the regular factory product (12%) on $50,000 of goods, this will amount to $6,000, a sum which in the first year of the establishment of the research work not only blankets the development expenditure, but will leave a small margin. In other words, the general manager has at little cost established an efficiently functioning, development department that is tied into the plant and engaged in the systematic production of new lines, and the direction of general production.

Assuming that the director has been supported to the extent that he has been able to increase the factory efficiency and adopted practices which have resulted in decreased losses, it can readily be seen that an investment like the one outlined can be still further productive, even within this stated time. Very few manufacturers give close attention to the many preventable losses. Few manufacturers know what these losses are. Lack of close supervision of workmen and even of foremen creates a condition where these losses are covered up and certainly not recorded. While it is true that the successful product must stand loss expense if the concern is to be operated at a profit, yet this does not solve the problem of preventable loss. It merely raises the price of the marketable goods and encourages a lax attitude among workmen and foremen.

Coöperation

It has already been stated that this is not a one-man activity. The results outlined could not possibly be attained unless the officials coöperated with the director in getting out the new lines. We started out by making a detached activity of the research department, but when the time came to produce the new lines, it is obvious that the director and the various foremen must work together. Also the business end of the concern must understand what is being done and why, and instructed to assist in every possible way. It is a simple matter to work out a program of activities,

CHART SHOWING GENERAL PRODUCTIVE RESULTS FOR FIRST YEAR

Activity / Month	1	2	3	4	5	6
Organization	Install equipment	Install equipment	Selection of samples	Costs and sale prices	Preparation for orders	Preparation for orders
Organization reports	Factory conditions		Report to Gen. Mgr.	Cost estimates	Cost estimates	Cost estimates
Research program	Covering first 3 months			Production program		
Research reports	Decorative processes	Chemical exposition, etc.	Summary three months	Decorative processes	Production report	Production report
Research records	Necessary process records	Necessary process records	Process records	Process records	Process records	Process records
Sketch designs	50 sketches		15 sketches	10 sketches	5 sketches	10 sketches
Working drawings	12 shapes	12 shapes	10 shapes	12 shapes	10 shapes	5 shapes
Models	12 models	12 models	10 models	12 models	10 models	5 models
Molds	12 molds	12 molds	10 molds	60 molds	100 molds	150 molds
Clay wares	150 pieces	150 pieces	50 pieces	200 pieces	50 samples	50 samples
Glaze experiments	20 glazes	50 glazes	50 pieces	20 glazes	20 glazes	20 glazes
Color standardization		10 glazes	20 glazes	20 glazes	20 glazes	20 glazes
Decorated wares	50 pieces	50 pieces	50 pieces	100 pieces	50 pieces	25 pieces
Glazed wares	100 pieces	100 pieces	50 pieces	100 pieces	100 pieces	75 pieces
Research wares out of glost kiln		150 samples	250 samples	100 sales samples	Line B	Line D
Wares selected for factory production			25 pieces each Types A and C		25 pieces	25 pieces
Wares filed for future reference			350 pieces		Line B 175 pieces	Line D 100 pieces
Wares released for market				Lines A and C	Line B	Line D
Orders received						Orders $2,500
Amount factory production						
Research dept. expense	$2,000	$1,800	$1,200	$2,100	$1,800	$1,650
Factory production direct, indirect labor and material costs only					$500	$600

CHART SHOWING GENERAL PRODUCTIVE RESULTS FOR FIRST YEAR

Activity / Month	7	8	9	10	11	12
Organization	Labor and production program		Report on market			Conference next year program
Organization reports	Cost estimates	Cost estimates	Cost estimates	Cost estimates	Cost estimates	Cost estimates
Research program	Program for new lines			Outline for next year	Program next year	Program next year
Research reports	Production report	Production report	Chemical exposition, etc.	Production report	Production report	Production report
Research records	Process records	Process records	Process records	Process records	Process records	Process records
Sketch designs	10 sketches		20 sketches	20 sketches		
Working drawings	4 shapes	4 shapes	4 shapes	4 shapes	4 shapes	4 shapes
Models	4 models	4 models	4 models	4 models	4 models	4 models
Molds	150 molds	100 molds	100 molds	250 molds	250 molds	250 molds
Clay wares	200 samples	50 samples	20 samples	20 samples	20 samples	20 samples
Glaze experiments	20 glazes	20 glazes	20 glazes	20 glazes	20 glazes	20 glazes
Color standardization	20 glazes	20 glazes	20 glazes	20 glazes	20 glazes	20 glazes
Decorated wares	50 pieces	50 pieces	20 pieces	20 pieces	20 pieces	20 pieces
Glazed wares	150 pieces					
Research wares out of glost kiln	Additions to lines A-D	50 pieces	20 pieces	20 pieces	20 pieces	20 pieces
Wares selected for factory production	20 pieces A-D				20 pieces	
Wares filed for future reference	100 pieces	50 pieces	20 pieces	20 pieces	20 pieces	20 pieces
Wares released for market	20 pieces A-D				Line E	
Orders received	$4,000	$6,500	$9,000	$12,500	$15,500	$20,000
Amount factory production	$2,500	$4,000	$6,500	$9,000	$12,500	$15,500
Research dept. expense	$2,300	$1,700	$1,500	$1,200	$1,650	$1,500
Factory production direct, indirect labor and material costs only	$900	$1,300	$1,600	$2,100	$2,600	$3,000

but this can not be carried out if there are periods of delay due to no other reason than the attitude of reactionaries. Too often a research director has been given authority by the general manager, but this fact has not been made clear to the various officials who resent what they consider an intrusion and an unnecessary and additional expense. If this attitude results in the holding up of orders for supplies, in delaying shop practices, keeping the research work from the kilns, and the thousand and one other tricks known to the average official, the director of the activity has a hopeless task, unless he is aggressive and resourceful enough to force his program through; and in this case he can not do this without incurring the enmity of the various plant officials. While few directors desire such a condition, there is no other method of attack than to consider the activity as a purely impersonal one, and to carry out the program irrespective of opposition, after friendly coöperative measures have failed, and after it is definite that the general manager hesitates to give the desired authority.

The most satisfactory production policy is obviously that where the general manager will call the various executives in conference. These round table talks inevitably smooth out difficulties and practically eliminate jealousies, at least among interested and efficient officials. The jealous reactionary who is perpetually afraid of losing his job, and who will toady to the boss, while accepting no authority from any other quarter, and who will fiercely obstruct any development rather than have the present conditions changed, can not be removed too quickly. While his particular department may seem on the surface to be efficiently conducted, an impersonal investigation will quickly prove that this man is a very costly part of the organization.

Jealousy is the most costly and dangerous condition in a business organization. It should be stamped out as quickly as a fire. An official who is jealous of another and who fears the promotion of another is not only retarding general progress, but he is, as stated, inefficient in his own department.

There are so many specialized activities in the ceramic industry, each offering almost unlimited possibilities that there is no excuse for an official to be in a state of mind where he is afraid of the success of another member of the organization. Of course, the only solution is in the organization chart, and in the round table conferences of the general manager or plant superintendent, and these are not possible unless the general manager is sympathetic to such a condition.

To properly realize the results of efficiency in a perfectly coördinated organization, it is only necessary to compare the average organization in the ceramic field with those of other large national industries and business activities.

Organizations like the Standard Oil, General Electric, United States Steel Corporation, Victor Phonograph Company, Ford Motor Company, National Cash Register Company, Curtis Publishing Company, The Prudential Insurance Company, the various rubber companies, packing houses and the larger banking organizations could not exist if absurd and petty obstructions of jealous officials were allowed to permeate all through the plant. But the ceramic industry is choked with this condition, and it is one of the chief reasons why there is no single ceramic organization in this country that can compare in size or volume of business with the type of concern mentioned. Yet, the ceramic business is one of the most essential industries in the world.

It is doubtful if the industrial and business activities mentioned have practical and technical difficulties experienced by the potter. Yet there is no other industry so lacking in regard to efficient organization and expert direction. The technical problems are being efficiently worked out, and probably no other country possesses the high class of specialized technical help, but the biggest technical men or any other class of specialists do not make an organization, and they are not worth the salary of the least skilful workman on the plant if they are not in a position to use their knowledge and ability.

Size of Initial Organization

So far as personnel is concerned, the research department consists of the director, his personal secretary or record clerk and a student assistant. If the director himself can outline the program, make the designs and working drawings, molds and models, prepare the bodies and glazes, make and decorate actual samples, and if necessary, fire the wares, in short, if he is a thoroughly practical craftsman, no further assistance is needed until the activity is large enough to necessitate the director's attention in connection with production problems and increased research activities.

It is reasonable to assume that a person capable of directing a ceramic art activity should be personally able to carry out the various processes. If this fact is not recognized, it is easy to see that an initial organization must consist of three or four specialists, who would require a collective remuneration that would make a thoroughly efficient research organization in the average plant a questionable undertaking from a financial point of view—which is the only point of view a successful manufacturer can consider.

The Manufacturer's Interest in Research

There are a number of manufacturers who would be immediately interested in research work if they could be assured of reasonably tangible

and marketable results within a stated period, and at a definite cost. A manufacturer who is buying a piece of equipment, or planning an addition to his plant knows what this is going to cost, and what the result will be. A research department is also an addition to and a part of the business organization, and consequently it should be subject to the same supervision and control as any other portion of the plant.

The manufacturer's chief interest, it must be remembered, is not in purely scientific research but in salable and profitable quantity production, consequently, he is not likely to give favorable consideration to a program that can at best only promise results in the future, and incidentally, that because of its highly scientific nature, can not at once be tied into the factory organization.

If a building is on fire, one can not wait for a perfect extinguisher to be developed, nor will any amount of theoretical work as to the cause of the fire serve any present result. It is a case for immediate action with the best equipment at hand. The scientific inquiry can accompany, or follow the active work of putting out the fire, and the results charted and used for future occasions.

The same condition exists in connection with the average present day ceramic art plants. From an organization point of view, they are in a chaotic condition, and nothing but a coördination of the various related essential activities with a directing head familiar with each branch of the work can develop the entire activity to the point where it is functioning as efficiently as is considered necessary in other large industrial undertakings.

Attitude of Research Director

In the organization described there is bound to be friction and opposition to a research program such as the one described. But the director of the activity must be broad enough to be able to interpret correctly this attitude. If he keeps the manager closely advised of the progress of the activity, and if he is frankly critical of his own work, no amount of opposition will be effective.

Fig. 2 illustrates the mental outlook of the efficient director, while Fig. 1 illustrates a state of mind that will react unfavorably in connection with any industrial activity no matter how much practical and technical knowledge the individual concerned may possess.

The actual results properly recorded and estimated in regard to costs will be the answer to any partisan criticism that may arise. And it can not be emphasized too strongly that the director must know at all times the costs in connection with the various activities under his direction.

I remember an instance where a very successful art pottery product was nearly discontinued because an office executive was not friendly to

the development activities. The general manager was too busy to go into details, and in asking questions regarding the cost of the product, would accept a general answer without referring to the actual cost report. The cost clerk who knew nothing of the selling price would give evasive answers to the effect that "the product was costing entirely too much." The manager was gradually led to assume that this was a very unprofitable undertaking, and because of the lack of coöperation, nothing was said to the director. When the decision to discontinue the line was finally brought to the attention of the director, he presented the actual figures involved, and on investigation, it was shown that the undertaking was a most profitable one. If the director had not kept records of the cost of production, no amount of explanation or persuasion would have satisfied the manager.

The research director must expect opposition, and he must just as consistently react against this as he does against another unfavorable condition. If he can succeed in winning over the unfriendly element, so much the better for the organization.

A research organization is in its best sense an *influence*. To be most effective, the results will be obtained in such a way as not to be directly traceable to the director or any single individual. It is contended that in an organization as outlined where the director is working through the various specialists and skilled workmen it can be an infinitely greater productive force than a more or less detached department comprising a number of skilled specialists conducting independent investigations.

Industrial Training

Because of the lack of ceramic industrial schools, the program of the art pottery concerned must give serious attention to educational matters. Where special skilled help can not be obtained, it must be developed. The research director must be on the lookout for favorable material and must create a condition where interested workers realize that they have an opportunity for acquiring increased experience and consequent advancement. The human element is the most difficult of all the elements with which the potter has to deal, yet it is the most plastic and responsive where the working conditions are most interesting and favorable.

Loyalty to the Organization

An attitude of unquestioned loyalty to the concern and its officials should be taken for granted. It is an impossibility for a research or development man to be fully efficient unless he is interested in his work, and attached to his concern. Even mental reservations are harmful and distracting, and interfere with results. There are always difficulties and

complications to deal with. These are the main conditions with which the research man must deal. They may affect the practical work, the working program, or the human element, or a combination of these.

Whatever the unfavorable condition may be, or however much cause there may be for dissatisfaction, it is up to the research man to put his work across in such a manner that it is as far as possible absolutely the property of the concern he is associated with. Too many ceramic specialists claim a paternal right to their particular processes and developments. They will fight to retain control of some essential part of the process.

If they leave the concern for any reason, they will produce identically the same things for the new concern. Such an attitude is either an out and out admission of inability to create new types, or it is deliberate dishonesty, because there is no question that the work done for the former concern is that concern's organization property.

If conditions are such that it is absolutely impossible for the research man to do productive work (and they would have to be very bad to legitimately admit this because it is possible to produce without the assistance of any individual on earth), then he should sever his connection and go somewhere else.

The individual who for any reason "soldiers" on the job, or develops an attitude of pessimism or distrust is a professional suicide so long as he is in that condition. Arnold Bennett made the statement that every man should see to it that his income increased at least ten per cent every year. It is obvious that this could not happen if there was no attempt to increase one's physical and mental equipment at the same rate.

In the final analysis, the researchist is a business man selling his wares to the manufacturer just as much as the manufacturer is in selling goods to the dealer. The dealer will not continue to buy from an untrustworthy manufacturer, neither will the latter for long retain the services of the research man who develops a disloyal streak because he is dissatisfied with conditions.

Some manufacturers have been criticised because they do not understand the difficulties under which the research men have to produce. Then it is the research man's job to demonstrate these difficulties and to show the manufacturer the possibilities.

The research man is a specialist just as much as the lawyer, the physician, and the banker. The manufacturer can not be expected to understand all the intricacies involved. If he did, he would not need the research man. But he can learn the fundamentals of the activity, and if the records are presented in a business-like manner, he can judge the results, and that is all the research man has a right to expect.

Business Training

Modern industrial research work is so tied in with business that it is essential that the research man have a first-class business training. Until a few years ago, this was practically an impossibility, and this is the reason why so few research men know anything about the commercial side of their respective industries. Such organizations as the Society of Mechanical Engineers, the Alexander Hamilton Institute, and the commercial courses in the various universities are catering to those professional fields where it is difficult to acquire a business training, so there is no longer any reason why the technical man should go through life limited in his opportunities because of this important essential in his professional equipment.

Coöperation with Research Organizations in Other Fields

The ceramic industry has not yet developed to that point where the various concerns would give favorable consideration to the establishment of a joint research laboratory. But this is no reason why organizations which are not competitive should not coöperate to the extent where process information could not be exchanged to mutual profit.

Art pottery must harmonize with its ultimate surroundings, therefore it is reasonable to assume that a friendly coöperation between the officials of an art pottery, a furniture factory, a textile plant, a carpet factory and wall paper house would result to the ultimate advantage of all concerned. There are many problems of design, style, color, etc., that would be worked out to a more satisfactory result. And there is no question that many decorative processes would be developed by the adoption of methods used in industries making an altogether different type of product.

American Encaustic Tiling Co.
Zanesville, Ohio

EFFECTIVENESS OF DIFFERENT METHODS OF MAKING ABSORPTION DETERMINATIONS AS APPLIED TO HOLLOW BUILDING TILE[1]

By Harry D. Foster[2]

ABSTRACT

The experimental work consisted primarily in selecting specimens from hollow tile from seventeen sources and saturating them for the absorption determination by (1) immersion in water at room temperature for various periods ranging from fifteen minutes to nine days, (2) boiling for various periods ranging from 1 hour to 5 hours and then cooling in water at room temperature for at least one hour, and (3) repeated vacuum treatments. The true porosity for some of the specimens was then obtained from the specific gravity and the per cent saturation reached by the various methods was calculated.

The results show that the five-hour boiling treatment gives results 1.2 greater than 72 hours immersion in cold water for the shale tile, 1.35 greater for the6fire clay tile, 1.20 greater for the surface clay tile, 1.25 greater for the mixed clay tile and 1.28 greater for an average of all tile. They also show that the cold water immersion treatment gives 73.5 per cent saturation, the boiling treatment 92.7 per cent saturation, and the vacuum treatment 97.0 per cent saturation.

In general the paper shows that the most consistent and practical way of determining the absorption of hollow tile is by boiling for five hours and then cooling for at least one hour before the saturated weight is taken.

Introduction

During the past two years a considerable amount of research work on hollow building tile has been conducted at the Bureau of Standards, primarily to obtain information on hollow tile as a fire retardant. Along with the fire tests, auxiliary tests are being made on representative tile to determine absorption, compressive strength, expansion, and resistance to freezing. This paper will deal only with the first one of the auxiliary tests named.

There are several ways of making absorption determinations as prescribed in specifications and building codes, as well as by more refined laboratory methods, some of which have been described in papers given before this Society. The question remained of determining the most practical method of making a determination for hollow tile that would also give fairly accurate and consistent results. It is evident that in anspector of tile could not take the time for long saturation periods nor in all cases have the equipment or patience required by the vacuum treatment for saturating his absorption specimens. He would generally, therefore, be limited to two methods, namely, immersion in cold water for a period not longer than about three days and boiling the pieces from one to five hours and then allowing them to soak for a short period thereafter.

[1] Published by permission of the Director, Bureau of Standards, Department of Commerce.

[2] Received June 22, 1922.

Since there is a considerable quantitative difference in results obtained by these two methods, the absorption of the hollow tile which are being studied was determined by each method and a comparison of the results obtained. Following this, the vacuum treatment was tried and later the true porosity of the specimens was calculated from their true specific gravity, and the per cent saturation obtained by the two former methods was found.

Method of Procedure

Some of the pieces on which the absorption determination was to have been normally made were taken for this study. They represented five shales, one marked "A," a strong shale from Indiana, two marked "B" and "C," blue Devonian shales from Iowa, one marked "D," a pure shale found in the vicinity of Louisville, Kentucky, and one marked "E," a mixture of two shales as found near Coffeyville, Kansas; six fire clays, three marked "F," "L," "M," from typical Ohio deposits, one marked "H," a very porous burning fire clay from Texas, and two marked "N" and "P," sandy New Jersey fire clays; three surface clays, one marked "O," a typical Chicago surface clay, one marked "Q," a Boston surface clay, and one marked "K," a New Jersey surface clay; and three kinds of mixed clays, two marked "G" and "S," mixtures of shale and fire clay, and one marked "R," a mixture of shale and surface clay. The percentage absorption was first determined by immersion for various lengths of time in water at room temperature and secondly, by boiling them for one, three, and five hours, respectively, and afterwards allowing them to soak for one hour in water at room temperature. This was followed by the vacuum treatment for saturating the specimens, and also by the determination of the true specific gravity which was done in order that the true porosity of the pieces might be calculated. By making this last determination it was possible to determine to what degree complete saturation was reached by the various methods which were used.

Selection and Preparation of Test Pieces

The pieces for the absorption determination were selected as follows: Three tile, one hard fired, one medium fired and one soft fired, were selected from each of the seventeen kinds of tile being studied. By means of a large stone saw these tile were then cut in two approximately equal parts, the cut being perpendicular to the length of the tile. One piece of each tile was then saved for a compressive strength determination to establish, if possible, the relationship between the absorption and compressive strength. The other piece was cut to give one complete cell from each tile so that a study of their resistance to freezing could be made. The pieces for the absorption work were then chosen from the remainder of the

tile. Care was taken that one of the three pieces used was from the center web of the tile and the other two pieces from opposite shells. This gave three pieces, each containing from twenty to thirty square inches, which were free from the usual cracks that would be found in pieces selected after compressive strength tests had been made, and which were representative of the uniformity of burning of the tile. The wide variation of the absorption results obtained from pieces of the same tile show the necessity of carefully selecting more than one specimen if the information obtained is to be taken as reliable.

Immersion Absorption Tests

The first absorption tests were made by saturating the specimens by immersion in water at room temperature. The pieces were arranged in small groups of convenient size and each group was carried throughout the entire procedure as a unit. They were dried to constant weight in an electric oven, and then immersed in water in a large tray, the suspended weight of each piece being taken after immersion periods of fifteen minutes, thirty minutes, one hour, three hours, six hours, one day, two days, three days, and nine days. During all of these weighings the pieces were not taken from the water. The last suspended weight of each piece was carefully checked and immediately it was taken from the water, allowed to drain one minute, the surplus water wiped off with a wet towel, and its weight in air was taken. The percentage absorption at the various intervals was then found by the use of the following formula:

$$\text{Per cent absorption} = \frac{(S_a - S_w + S_{wp} - D)}{D} \times 100$$

where D is the dry weight of the specimen, S_{wp} is the weight of the piece suspended in water at the time for which the absorption is desired, S_a is the final weight of the piece suspended in air, and S_w is the final weight of the piece suspended in water.

By this method of obtaining the increments of absorption from the suspended weight in water the chance of irregularity in the results is more or less eliminated. As determined from the suspended weight in air irregularities are introduced due to variations in the amount of water on the surface of the specimen, even with great care in wiping off the surplus water. This method is especially suitable for absorption rate determinations or for determinations made for comparison. As a further precaution the pieces were all weighed on the same balance and to the nearest 0.05 gram.

The results of the immersion tests are given in Table I. The average rate of absorption for the fire clay tile, for the surface clay tile, for the shale tile, for the tile made from the mixtures of raw materials, and also the average for all tile has been plotted in Figure I. This shows that the

increase in absorption is continuous throughout the nine days. It is clearly evident, therefore, that this would not be a consistent even though it may be a practical way of saturating specimens for the absorption determination.

TABLE I

RESULTS OF IMMERSION TESTS

Tile number	Percentage absorption when immersed								
	Minutes		Hours						
	15	30	1	3	6	24	48	72	216
Shale Tile									
A	6.83	7.36	7.78	8.46	8.73	9.15	9.41	9.58	10.10
B	1.25	1.59	1.68	2.90	3.09	3.56	3.76	3.95	4.43
C	1.63	2.16	2.78	3.96	5.00	6.19	6.43	6.56	7.08
D	7.68	7.97	8.12	8.38	8.54	8.95	9.19	9.37	9.90
E	9.41	9.51	9.63	9.93	10.14	10.97	11.45	11.72	12.42
Aver.	5.36	5.72	5.99	6.73	7.10	7.76	8.05	8.24	8.80
Fire Clay Tile									
F	7.04	8.10	8.78	8.63	8.86	9.08	9.40	9.58	10.16
H	9.41	9.65	10.08	10.55	10.67	11.76	12.22	12.55	12.94
L	4.60	5.43	5.50	5.61	5.74	6.12	6.44	6.97	7.43
M	4.91	5.22	5.32	5.52	5.65	6.18	6.43	6.64	7.24
N	5.44	5.82	6.09	6.77	7.05	7.65	8.05	8.40	9.52
P	6.06	6.90	7.50	7.85	8.16	8.76	9.31	9.73	10.53
Aver.	6.24	6.85	7.21	7.49	7.69	8.26	8.64	8.98	9.64
Surface Clay Tile									
K	8.66	9.24	9.47	10.03	10.43	11.79	12.25	12.45	12.86
O	17.51	18.68	18.92	19.40	19.74	20.67	21.23	21.70	22.63
Q	4.86	5.03	5.24	5.62	5.76	6.07	6.27	6.35	6.57
Aver.	10.68	10.98	11.21	11.68	11.98	12.84	13.25	13.50	14.02
Mixed Clay Tile									
G	5.81	5.93	6.01	6.22	6.31	6.75	7.03	7.26	7.91
R	7.71	7.86	8.06	8.49	8.76	9.42	9.77	9.88	10.25
S	4.26	4.99	5.26	5.46	5.61	6.02	6.25	6.36	6.88
	5 93	6.26	6.44	6.72	6.89	7.40	7 68	7.83	8.35
Average for All Tile									
	6.63	7.14	7.49	7.87	8.13	8.77	9.09	9.36	9.94

Boiling Absorption Tests

The specimens used in the immersion tests were redried to constant weight which was always within 0.5 of a gram of the original dry weight. They were then arranged in small groups and each group as a unit was placed in boiling water and boiled first for one hour, a second time for three hours, and a third time for five hours. After each boiling period the water was quickly cooled to room temperature by means of a flow of tap water, the specimens being allowed to soak in this water at room temperature for one hour. Their suspended weight was then taken and from this and the data obtained from the immersion tests the percentage absorption was calculated by the same formula.

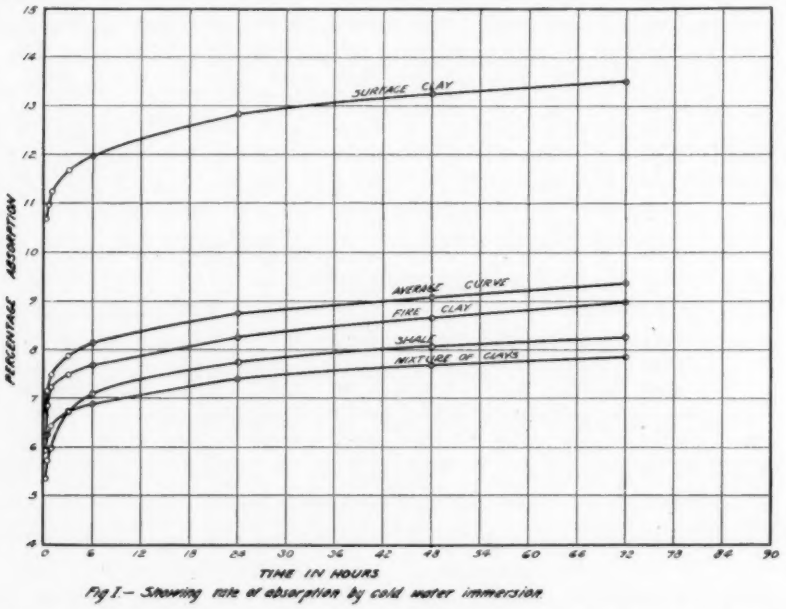


Fig I — Showing rate of absorption by cold water immersion

The results of the boiling absorption tests are given in Table II. A study of the average results as given in this Table shows that a more complete saturation was obtained by boiling five hours than by boiling one hour. The increased boiling, however, gave an increase in the percentage absorption of less than 0.3 per cent with all the tile except the surface clay tile in which case it ran as high as 0.7 per cent. It is doubtful whether the increased boiling period of five hours would be always worth while for hollow tile, but as a general procedure it may be advisable. We can then say that if the specimens are to be saturated by boiling they should be dried to constant weight, immersed in water, boiled for five hours, and then allowed to soak in the water for one hour after it has been cooled to room temperature before the saturated weight is taken.

TABLE II

RESULTS OF THE BOILING TESTS AND THEIR RELATION TO THE RESULTS OF THE 72-HOUR IMMERSION TESTS

Tile number	Percentage absorption when boiled 1 Hr.	3 Hr.	5 Hr.	Percentage absorption when immersed in cold water for 72 hours	Ratio 5-Hr. boiling 72-Hr. immersion
Shale Tile					
A	11.58	11.72	11.69	9.58	1.22
B	5.28	5.42	5.49	3.95	1.39
C	9.62	9.36	9.14	6.56	1.39
D	10.38	10.55	10.50	9.37	1.12
E	13.41	13.70	14.02	11.72	1.20
Average	10.05	10.25	10.17	8.24	1.26
Fire Clay Tile					
F	12.65	12.64	12.79	9.58	1.34
H	15.23	15.20	15.32	12.55	1.22
L	8.72	8.98	9.12	6.97	1.31
M	9.33	9.54	9.63	6.64	1.45
N	11.66	12.23	12.21	8.40	1.45
P	12.53	12.51	12.98	9.73	1.34
Average	11.68	11.85	12.01	8.93	1.35
Surface Clay Tile					
K	15.02	15.03	15.86	12.45	1.16
O	22.10	22.87	23.19	21.70	1.07
Q	8.17	8.41	8.57	6.27	1.36
Average	15.10	15.44	15.87	13.47	1.20
Mixed Clay Tile					
G	9.69	9.62	9.76	7.26	1.34
R	11.22	11.38	11.55	9.88	1.17
S	8.17	8.59	8.44	6.36	1.33
Average	9.69	9.86	9.92	7.83	1.25
Average for All Tile					
	11.45	11.66	11.78	9.36	1.28

Treatment by Vacuum Tests

In order to see whether the pieces which were studied could be more fully saturated and if so, how much, some were selected at random, re-dried and placed under a vacuum of 28 inches of mercury. After one

half hour under this reduced pressure, water was admitted to the vacuum chamber and the pieces were allowed to boil for one hour. While the pieces were still immersed the pressure was raised to one atmosphere and the specimens were allowed to remain in the water and cool over night. On the next day this process was repeated and the percentage absorption obtained. The results of this treatment are compared with those of the boiling treatment in Table III. The apparent porosity of the pieces so treated was 26.51 per cent as against 25.34 as determined from the five-hour boiling treatment.

TABLE III

RESULTS OF THE VACUUM TREATMENT AND THE SATURATION REACHED BY THE VARIOUS METHODS

Tile number	Apparent porosity by 72-hour immersion in cold water	Apparent porosity by boiling 5 hours	Apparent porosity by vacuum treatment	True porosity by specific gravity	Percentage saturation by 72-hour immersion in cold water	Percentage saturation by boiling 5 hours	Percentage saturation by vacuum treatment
K	24.05	30.16	31.00	31.20	77.1	96.7	99.4
L	13.54	19.23	21.53	22.61	59.9	85.0	95.1
M	17.65	19.91	21.41	22.56	78.3	88.4	95.0
N	16.08	23.68	25.15	26.67	60.3	88.8	94.3
O	36.34	38.76	39.50	39.98	90.9	97.0	99.0
P	18.66	26.46	27.37	27.90	66.9	96.7	98.1
Q	16.48	21.37	21.82	22.50	73.2	95.0	96.7
R	20.06	23.18	24.28	24.68	81.3	94.0	98.4
Ave.	20.36	25.34	26.51	27.26	73.5	92.7	97.0

Although a higher result could be obtained by this treatment than by the boiling treatment, the increase was not considered large enough to make its use warranted for inspection work. For this reason no extended work was done by this method.

Porosity Determinations

In order to see how nearly the pieces were saturated the percentage porosity for some of the pieces as determined from the amount of water absorbed by the various treatments was compared with that determined from the true specific gravity. For calculating the percentage porosity from the data of the various absorption methods the following formula was used:

$$\text{Per cent porosity} = \frac{(S_a - S_w) + S_{wp} - D}{(S_a - S_w)} \times 100$$

where D is the dry weight of the specimen, S_{wp} is the weight of the specimen suspended in water at the time for which the porosity was required,

S_a is the final weight of the piece in air, and S_w is the final weight of the piece suspended in water.

The specific gravity necessary for determining the true porosity was found by the standard method as adopted by the American Ceramic Society.[1] Some of these determinations were also checked by means of the cement bottle.

With this data the true porosity of the specimens was calculated by the following formula:

$$\text{Per cent porosity} = \frac{(S_a - S_w) - \frac{D}{Sp.\ Gr.}}{(S_a - S_w)} \times 100$$

where D is the dry weight of the tile specimen, S_a the final weight of the piece in air and S_w the final weight of the piece suspended in water.

The results of these calculations are given in Table III. Assuming that all of the pore spaces in a piece could be filled this table also shows how fully the pieces were saturated by the various treatments.

Comparison of Results

The average results of this work have been summarized in Table II. As seen from this table the results from the boiling determination are always greater than those from the cold water determination, even when the immersion period is drawn out over a period of nine days. Quoting from "An Investigation of Tests of Iowa Shale Drain Tile"[2] by W. J. Schlick who did some similar work on Iowa shale tile, "The result of the boiling determination is equal to or greater than the result when the specimens are immersed in water at room temperature for 50 to 70 days."

Table II also shows that the boiling treatment gives results 1.26 times greater for shale tile than that obtained by 72 hours' immersion in cold water, 1.35 times greater for fire clay tile, 1.20 times greater for surface clay tile, 1.25 times greater for mixed clay tile, and 1.28 times greater for an average of all tile. As can be seen from the results of "B" and "C" our ratio of 1.39 for Iowa shale tile checks closely with the ratio of 1.40 as given by Mr. Schlick.[2] A part of the unfilled spaces probably were closed, while the remaining unfilled spaces were such that they could be filled only by long and repeated vacuum treatments.

In Figure II the ratio of absorption by boiling to that by cold water immersion is plotted against the absorption by cold water immersion as given in Table II. From this it is seen that the ratio varies in a direction

[1] *Year Book*, 48 (1921–22).

[2] *Bulletin*, **49**, Engineering Experiment Station, Iowa State College of Agriculture and Mechanical Arts.

inverse to that of the percentage absorption. As indicated by this curve, when the absorption, determined by the 72-hour immersion, is between 3 and 8 per cent, the ratio may be taken as 1.35, when it is between 8 and 16 per cent its value is about 1.25, and when it is higher than 16 per cent the ratio can be taken as 1.10.

The degree of saturation attained by the various treatments for some of the tile is shown in Table III. From this we see that an average saturation of 97.0 per cent was reached by the vacuum treatment, 92.7 per cent by 5 hours' boiling and only 73.5 per cent by cold water immersion for 72 hours.

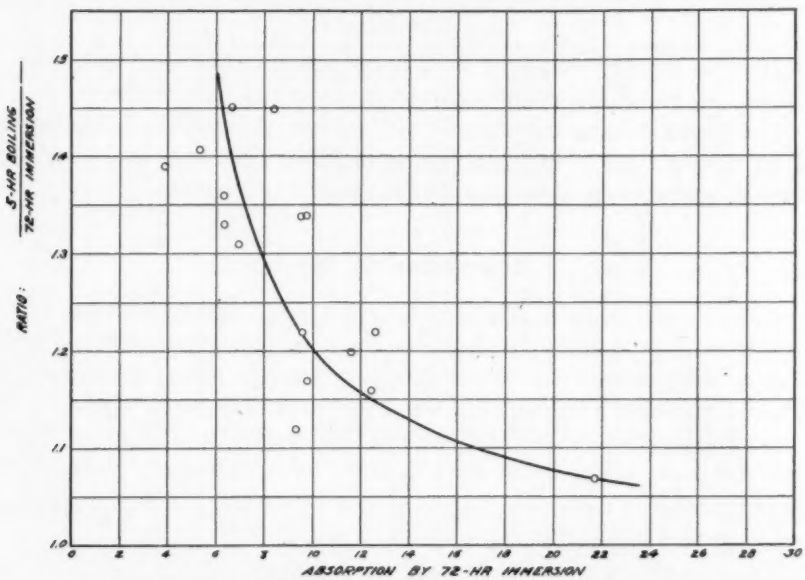


Fig. II.—Showing the relation between the boiling and the cold water determinations.

Conclusions

From this work the following conclusions can be drawn:

1. Specimens for the absorption determination can not be fully enough saturated by 72-hour immersion in cold water to give practical and consistent results.

2. The vacuum treatment gives the most complete saturation of specimens, but due to the apparatus required would hardly be practicable for general adoption.

3. The best practical method for saturating hollow tile specimens for the absorption determination is by boiling for five hours, cooling the water and the specimens to room temperature, and then allowing them to soak at least one hour before the saturated weight is taken.

4. If the absorption determination has been made by 72-hour immersion in cold water at room temperature the result should be multiplied by the proper factor (average value 1.28) in order to compare it with results which have been found by the five-hour boiling method.

It should be noted that while these results may be true qualitatively they will not be true quantitatively for brick and other products where a specimen of a different thickness is used.

Acknowledgments

The work of which this paper forms a part is conducted at the Bureau of Standards in coöperation with the Hollow Building Tile Association. The writer wishes to express his appreciation to Mr. S. H. Ingberg, Chief of the Fire Resistance Section, for valuable help and suggestions, and also to Mr. E. J. Maguire for his help with the experimental work.

Bureau of Standards
Washington, D. C.

INVESTIGATION OF DUST PRESS PRACTICE AS INFLUENCING FINISHED SIZES AND CRACKING

By H. Spurrier

ABSTRACT

Owing to erratic firing behavior, the factors affecting finished sizes of ware were investigated. Uneven distribution of air and water content and uneven density produced irregular shrinkage and consequent cracking and warping. The percentage of water in the clay as pressed is shown to be the dominant factor as affecting shrinkage.

Suitable loading of die corrected the differential shrinkage.

Experimental procedure is detailed. Influence of rate of pressing on porosity is set forth.

Introduction

Owing to rather serious losses in ware, consequent upon variations in finished size and cracking, it was thought advisable to make a survey of current practice, with a view to minimizing such losses.

Two pieces in particular were selected as being at once the greatest offenders and also as affording the best opportunity to obtain positive results.

One piece was known as a "T Rest," 12.48 inches in length and had a green weight of nearly three pounds, of somewhat simple design with no perforations.

The other known as a "Jack Panel" of rectangular outline possessed a number of ribs and a large number of perforations of various sizes and weighed about $3^1/_2$ pounds in the green state.

Great anomalies had presented themselves in regard to length variations of the "T Rest." Pieces coming from the same sagger showed variations of a quarter of an inch, consequently, one piece exceeded the maximum and the other did not reach the minimum size.

It was at once seen that these variations could not be charged to firing differences, because the differences noted amount to 2.2% of the total length of the piece, the normal shrinkage being 12.5%. A very simple calculation shows us that the variation calculated on the expected shrinkage amounts to 17.6% and this is, of course, impossible if it be considered as arising from firing alone and without some accessory cause, more particularly as the firing differences could not at most have exceeded 2 cones.

Causes of Variation

Accordingly, the likely causes of variation were tabulated in order that they might be followed up one by one, if necessary: Variations in (1) fired weight and effect of mass on shrinkage in various directions, (2) apparent density, (3) dry shrinkage, (4) loading die, (5) rate at which pressure is applied, (6) pressure per square inch, (7) water content of green dust, (8) physical condition of dust caused by temperature and time difference in tempering.

The two most nearly constant factors were: (1) the composition of the clay mix, (2) the firing.

It was impossible to develop any rationale as to size as the pieces came from the kilns, oversize and undersize coming from contiguous saggers, or even from the same sagger.

The fired weight showed irregular variations and nothing of value could be gained in this way.

The next step was to weigh and measure up a large number of pieces as they came from the dry rooms, while the pieces were in their original relative positions as placed by the pressmen. Here a variation of $8^1/_2$ per cent in weight and $^1/_8$ inch in length was found, and on tabulating the results some semblance of order was observed.

Eight skids or stillages were selected for this purpose. It was found that changes took place abruptly, measurements running uniformly for a while and then suddenly changing, suggesting a change in the clay itself.

As these pieces all came from dies of exactly the same length, the variations in length of the dry pieces could only be attributed to drying shrinkage which in turn must be considered as a function of the water content principally of the clay as pressed.

Mass, of course, influences shrinkages differently in various directions as is evidenced by a shrinkage on these "T Rests" of 10.57 per cent longitudinal and 11.25% transverse.

Design also influences shrinkage, but as these pieces were all alike this was considered as a constant factor.

The next step was to consider carefully the exact influence of water content of the dust.

It is obvious that if pieces are pressed from dust of varying water content the drying shrinkage will vary also, but a given increment in water content is not attended with a quite proportionate increment in drying shrinkage, the consequence being that such a piece will be proportionately more porous.

Experiment proved that the increased porosity of the dry piece, consequent upon high water content in the original dust, brought about increased fire shrinkage.

This is true whether the porosity is brought about by water drying out of a pressed piece or whether the porosity is due to air occluded in the pugging operation that precedes the working of bodies in the plastic form.

The differences in porosity of dried and unfired bodies is made easy of determination as follows:

The dried specimens are placed in melted paraffine wax in such a manner that they are not quite submerged. After thorough impregnation they

are removed from the paraffine and allowed to become cold. They may then be easily sectioned for microscope examination.

This is best conducted with low power and using a vertical illuminator if an eye-piece grating is used, the actual proportion of voids can be easily ascertained.

Accordingly three lots of dust were prepared containing 16.2%, 16.8% and 17.6% of water, with which three sets of "T Rests" were pressed up.

In order to avoid the necessity of weighing the dust an attempt was made to measure the dust loosely filled into a pan and then struck off evenly with a stick. It was hoped in this way that a volumetric measurement might be made to act as a guide to the water content, but for the three moisture contents noted, the weight volume relation varied insufficiently to be used as a guide; the following figures were obtained when the dust was measured as above noted.

For dust with a water content of 16.2% were obtained 2 lbs., 4½ oz., and 2 lbs., 4½ oz.

For dust with a water content of 16.8% were obtained 2 lbs., 4¼ oz., and 2 lbs., 4½ oz.

For dust with a water content of 17.6% were obtained 2 lbs., 4 oz., and 2 lbs., 3½ oz.

It is interesting to note that under these conditions an increase of the percentage of water contained in the dust resulted in a slight reduction in the weight of a given volume, which in turn indicates that wet dust occupies more space than drier dust would do.

Such differences as these were considered entirely useless for the purpose of determining the suitability of a dust for a given piece of work.

TABLE I

DUST CONTAINING 16.2% MOISTURE

No.	Original weight	Dry weight	Dry length	Fired weight	Fired length	% Dry shrink.	% Fired loss weight	Per cent shrink.
1	2–10	2–3	10.906	2–2	9.953	1.68	19.04	10.28
2	2–13½	2–7	10.906	2–5	9.953	1.68	18.68	10.28
3	3–0	2–9	10.906	2–6	9.906	1.69	20.70	10.70
4	2–15½	2–8½	10.922	2–5½	9.875	1.56	21.05	10.99
5	2–14	2–6	10.922	2–5	9.875	1.56	19.60	10.99
6	2–13½	2–7	10.891	2–3½	9.891	1.83	21.90	10.84
7	2–13½	2–6	10.875	2–3½	9.875	1.97	21.90	10.90
8	2–14	2–7	10.891	2–4½	9.906	1.83	20.65	10.70
9	2–14½	2–6½	10.906	...	...	..	...	...
10	2–13	2–5½	10.891	2–3½	9.906	1.83	21.10	10.70
11	2–14	2–6	10.891	2–3½	9.891	1.83	22.80	10.84
12	2–13½	2–5½	10.875	2–3	9.875	1.97	23.00	10.90
			.047″	Max.	9.953			
	Max. Variation		3/64	Min.	9.875			
				Diff.	.078			
				Ave.		1.76	20.94	10.74

TABLE II

DUST CONTAINING 16.8% MOISTURE

No.	Original weight	Dry weight	Dry length	Fired weight	Fired length	% Dry shrink.	% Fired loss weight	Per cent shrink.
1	2–15 1/2	2–7	10.844	2–5	9.844	2.25	22.1	11.27
2	2–12 1/2	2–5	10.828	2–2 1/2	9.828	2.39	22.4	11.40
3	2–14	2–6 1/2	10.844	2–4	9.812	2.25	21.7	11.54
4	2–14	2–6 1/2	10.844	2–4	9.859	2.25	21.7	11.12
5	2–15	2–6	10.859	2–5	9.859	2.11	21.2	11.12
6	2–14	2–6	10.844	2–4 1/2	9.844	2.25	21.2	11.12
7	3–0	2–7	10.844	2–5 1/2	9.844	2.25	21.8	11.12
8	2–15	...	....	...	...	..	...	...
9	2–14 1/2	2–6 1/2	10.859	2–5	9.812	2.11	20.5	11.40
10	2–15	2–6 1/2	10.859	2–5	9.812	2.11	21.2	11.54
11	2–14	2–6	10.859	2–3 1/2	9.812	2.11	22.8	11.54
12	2–15	2–7	10.844	2–5 1/2	9.828	2.25	20.1	11.40
				Max.	9.859			
	Max. Variation	.031		Min.	9.812			
		1/32		Diff.	.047			
				Average		2.21	21.5	11.32

TABLE III

DUST CONTAINING 17.6% MOISTURE

No.	Original weight	Dry weight	Dry length	Fired weight	Fired length	% Dry shrink.	% Fired loss weight	Per cent shrink.
1	3–0	2–6	10.828	2–5	9.719	2.39	22.92	12.48
2	2–14	2–7	10.813	2–3 1/2	9.719	2.53	21.82	12.48
3	2–15 1/2	2–7	10.781	2–4 1/2	9.734	2.81	23.16	12.25
4	2–12	2–4	10.797	2–1	9.734	2.67	25.00	12.25
5	3–1	2–7	10.813	2–6	9.734	2.53	22.60	12.25
6	3–0 1/2	2–6 1/2	10.797	2–5 1/2	9.719	2.67	22.60	12.48
7	3–1 1/2	2–7 1/2	10.813	2–6	9.719	2.53	23.20	12.25
8	3–4	2–9	10.813	2–7 1/2	9.734	2.52	24.04	12.25
				Max.	9.734			
	Max. Variation	.047		Min.	9.719			
		3/64		Diff.	0.15			
				Average		2.58	23.29	12.33

In these tables the loss in weight from green dust to dried pressed ware agrees pretty closely with the moisture determination made on the dust as shown at the top of each sheet, and when the loss that takes place in handling is taken into account, it is very close.

It is evident that water content is the chief factor in controlling shrinkage in ware made by dust press methods.

It is, of course, well known that if wet dust is used porous ware is the result. However, the increased drying shrinkage due to using wet dust is not proportional to the increase of water content and this unavoidably throws a greater burden on the fire shrinkage with consequent increased risk of cracking.

The following figures will make this fact clear:

Moisture content	16.2%	16.8%	17.6%
Drying shrinkage	1	1.037	1.0864
Total shrinkage	1	1.255	1.466
Shrinkage dry to fired	1	1.014	1.086
Per cent shrinkage dry to fired	8.98	9.11	9.75
Using 16.2% clay as 100 the ratios are	100	101.44	108.57

The explanation of these facts is to be found in the difference in specific gravity between the displacing water which is 1 and the displaced body which is 2.6. The great importance of this becomes evident when we realize that for every unit weight of water included, 2.6 unit weights of body are excluded to make room for it.

A further and important contributory factor is that the more moist the dust, the greater is the volume of occluded air.

The more moist the dust the coarser will it be, other things being equal, and consequently the greater will be the volume of air voids. In pressing such dust, as the two portions of the die come together, the piece is compressed from the outside inward, the exterior becomes close and nonporous before the inner portions feel the full effect of the pressure.

A distressing evil attending the use of wet dust is the swelling and frequent cracking of pieces so pressed, due to the expansion of the occluded air which can not find its way through the close outer surface as quickly as the pressure is released; this is especially noticeable in heavy pieces. This sets a definite limit to the safe rate of pressing.

It is interesting to note how positively the shrinkage follows the water content. The shortest piece of the batch containing 16.2% moisture is 9.875″ and the longest of the 16.8% batch is 9.859″, so we see a difference of .6% moisture has been sufficient to distinguish sharply between specimens pressed from the one or other of the two lots of dust. In like manner the shortest piece of the 16.8% dust is 9.812″ and the longest piece of the 17.6% dust is 9.734″. A total difference of 1.4% moisture has produced a difference of .141″ in length.

It was felt that this data was good enough to warrant a large size effort, consequently the usual number of "T Rests" were placed in the kilns. The moisture content of the dust used in making these rests was held between 16.1% and 16.3%. The result was very gratifying as not a single rest was rejected on account of size limits; this had never happened before.

Having the "T Rest" question settled, attention was addressed to the "Jack Panel" in which, in addition to all the usual shrinkage antics, warping and perplexing crackage were abundant.

Strangely enough this piece did not seem amenable to the established rule that had applied to "T Rests" and which had quite confidently been applied, but with indifferent results.

It became at once evident that other factors were complicating the case. Accordingly, in order to ascertain the approximate amount and distribution of the air in the green panels one or two were placed (separately, of course) in a bath of nearly boiling water; as the piece slacked down the relative amount of air could be estimated pretty well, and the mode of its distribution could be made out very nicely by the pattern of froth produced by the rising bubbles. Conversely the distribution of clay could be fairly well assessed.

This simple procedure of a hot bath for a sick piece of clay, is strongly recommended as a first aid in time of trouble—it reveals a great deal to the observant eye.

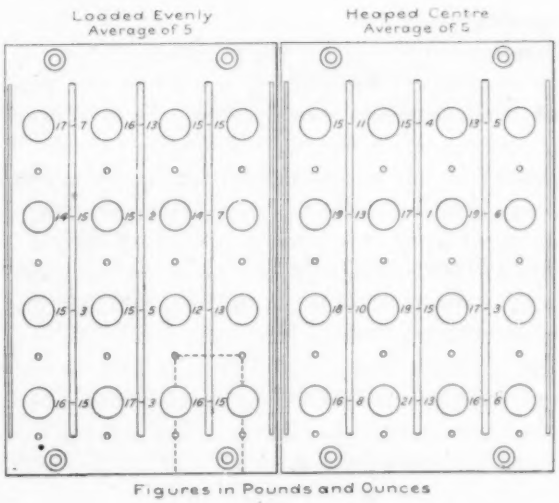


FIG. 1.

A very striking lack of homogeneity was displayed and a number of experimental lines were tried out simultaneously.

Several of the dried green panels were cut along the lines of the holes into five strips which were very carefully placed in sanded saggers and then fired. This procedure revealed two points of considerable interest: (1) There was a differential shrinkage, the inner members shrinking more than the outer ones; (2) The two outer or side members warped convex on the outside edges.

This indicated that the panels were less dense inside than around the edges which could only be interpreted as internal stress during firing which would inevitably tend to cracking.

Several fired panels were broken and the apparent specific gravity of the inner and outer portions was determined; the results of these deter-

minations confirmed the idea of uneven air distribution; the average of a number of determinations showing:

Density of inner portion	2.3105
Density of outer portion	2.3415
Difference	.0310

As such a state of affairs seemed to involve the crucial point, an attempt was made to secure further corroborative evidence. Accordingly a number of the dried and unfired panels were sawed into strips along the lines of the holes and then these strips were sawed crosswise at the small holes, thus making a series of pieces rudely similar to cement test briquettes which were then broken in an improvised machine and the breaking strains plotted on a drawing of a panel.

The figures obtained fully bore out the indications of the two former tests.

Although the figures for these breaking tests were not quite regular still the central portion of the panels showed a decidedly lower breaking strength than the outer portions of the panels.

The large number of pins in this die quite naturally caused considerable local differences in breaking strength, because wherever the clay is slicked along a hard surface it is always denser than where this is not the case.

Need was felt at this juncture of more positive information as to the actual movement of the dust in the die as it was felt that this might assist in formulating corrective measures. Accordingly, a die was loaded half full of dust, and then fine black cotton threads were moistened and laid quite straight between and parallel to the longitudinal rows of pins. The loading was then completed, the dust stricken off level and the usual pressure applied. The piece was then allowed to become leather hard, whereupon the clay was cut away from the upper surface in such a manner as to expose the black threads, the convolutions of which showed very plainly the trend of the dust movement which took place during the pressing.

Of course, it is reasonable to suppose that the transverse movement of the clay was greater than is indicated by the threads, because as the threads moved transversely a longitudinal shortening was necessitated which means that the thread must have been drawn through the rapidly hardening piece in a longitudinal direction thereby overcoming the consequent binding action, and this movement must have taken place at considerable speed. Wherever cracking had occurred which always took place at the sides, two points were noted, *viz.*, the ends were concaved and the sides were convexed, moreover, the cracks were always wider at the outside edges, which of course seems axiomatic, but of none the less significance.

In view of these several experiments and results it was reasoned that if the dust were heaped gradually toward the center of the die the clay

would suffer initial compression in the center and ultimately sustain greater pressure at this area resulting in greater density there than would be the case in an evenly loaded die.

This conclusion was put into practice using the threads as before described, several panels so made abundantly bore out the correctness of this reasoning.

The stronger areas, as determined by five sets of breaking tests, had now been transferred to the center.

Conclusions

The average and individual breaking tests showed considerably higher values; the air distribution was more even and the flow lines of the dust in the die as indicated by the cotton threads showed that greater movement had taken place from the center to the sides of the piece. Ten pieces made in this manner were sent to the kilns, all coming out without a flaw and comfortably within the toleration limits, $^1/_{16}$ inch.

During the progress of these experiments some contributory work was undertaken designed to determine the influence of the rate of pressing on the porosity of the finished piece.

Porosity determinations were made upon a standard piece as then being pressed which gave a value of 3.42.

Pieces were then made at a slower rate of pressing which showed a porosity of .66.

Pieces were also made at a still slower rate of pressing which showed a porosity of .37 per cent.

After the porosity tests were made the pieces were divided into two parts and one part of each was ground down with carborundum and water upon a sheet of ground glass. These pieces made the porosity difference optically so obvious that it was considered worth while showing them here.

The outstanding feature noted in this investigation is the dominant influence exercised by the water content of the dust on the shrinkage characteristics of the fired piece. Not only is this true of dust pressed ware, but it applies equally to plastic or leather hard operations.

It is hoped that the methods adopted may be useful in helping others out of similar difficulties which are sometimes very exasperating and which lead to considerable financial loss.

SQUARE D CO.
PERU, INDIANA

THE EFFECT OF SOURCES OF PIG IRON UPON THE ENAMELING OF CAST IRON

By M. E. Manson

ABSTRACT

Cast iron made from certain "northern" pig iron blistered badly, while that made under the same conditions from "southern" pig iron enameled satisfactorily.

The use of "northern" iron results in castings with low content of combined carbon although the other constituents usually determined in cast iron were present in about the same quantities as found in cast iron made from "southern" pig iron.

Reducing the silicon in the iron made with the "northern" pig iron from 2.80 to 2.30% with a total carbon content of 3.30%, resulted in the elimination of blistering in the enameling operations. Experiments have indicated that cast iron of this type with combined carbon less than 0.15% will develop blistering. However, it has not been definitely determined as yet whether the blistering is due directly to this low carbon content or to the presence of some other constituent not generally determined in a chemical analysis of cast iron.

Micrographs are shown of various irons before and after enameling. While these show some differences, it has been impossible to detect the cause for the blistering by means of them. All blistering irons, however, show in the micrographs characteristic dark blotches which have not as yet been identified.

Comparatively little attention has been given to the chemical composition of cast iron which is to be enameled. The generally accepted view is that any kind of iron can be enameled, and foundry requirements govern the composition. At the plant where the writer is employed, in manufacturing enameled sanitary ware by the dry process, we have apparently discovered a cast iron which can not be enameled or at least can only be enameled with great difficulty.

Before the war, the company used "southern" pig iron for the major portion of the charge. That is, it was iron from furnaces in the Birmingham district. At that time this iron could be bought f.o.b. to Milwaukee for the same price as the so-called "northern" iron, which comes from furnaces in the Chicago region. In 1917, however, the "southern" furnaces stopped their practice of equalizing rates, and "southern" iron became considerably higher priced than "northern."

Naturally, it became desirable to use "northern" iron. Using "southern" iron, the company had adopted a specification which gave very good results in both the foundry and enameling room. A cupola charge of 2000 pounds consisted of scrap 900 pounds, "southern " iron 800 pounds, and "northern" iron 300 pounds. The pig iron was so chosen that the castings gave an analysis of silicon 2.80%, sulphur .090%, phosphorus .70% and manganese .50%. With total carbon around 3.20 to 3.30%, the combined carbon stood at about .35% This composition was maintained with very little variation, day in and day out, and this iron, though the pig iron might come from various companies, as long as the "southern" "northern" ratio was maintained, gave very satisfactory results.

When the attempt was made to substitute "northern" for "southern" iron, no change was made in the specification for the cast iron. The cupola charge consisted of 900 lbs. scrap, 800 lbs. "northern" and 300 lbs. "southern" iron. Our castings, as before, analyzed silicon 2.80%, sulphur .090%, phosphorus .70% and manganese .50%. Results in the foundry were about the same but when the castings were enameled, much trouble was experienced from pinholing. It was not a case of a pinhole here and there, which could be patched by the enameler. Whole tubs would be entirely covered with blisters.

Pinholes or blisters can be attributed to many causes, such as minute holes in the casting, poorly cleaned iron, underburned ground coat, etc., but in this case the cause was directly due to the use of "northern" pig iron in place of "southern." It was general, appearing on every piece, large or small.

An analytical investigation disclosed the fact that while the analyses of the two irons were identical with respect to silicon, sulphur, phosphorus and manganese, the carbons were different. Table I gives some typical analyses of the two irons:

TABLE I

Cupola charge	Silicon	Sulphur	Phosphorus	Manganese	Comb. carbon	Graph. carbon
800 lbs. southern	2.92	.101	.69	.48	.30	2.92
300 lbs. northern	2.97	.088	.68	.52	.34	2.93
900 lbs. scrap	2.80	.093	.71	.52	.30	3.04
	2.76	.080	.69	.53	.32	2.95
800 lbs. northern	2.91	.107	.68	.51	.05	3.11
300 lbs. southern						
900 lbs. scrap	2.70	.088	.69	.50	.11	3.20

Other things being the same, the percentage of carbon which will be in the combined form in a casting, can be controlled by the silicon. By increasing the silicon content, the combined carbon is decreased, and vice versa. Yet, with the same silicon in the second mixture as in the first, the combined carbon is very low. Our next step was to lower the silicon in the iron and we found that by carrying a silicon content in the casting of about 2.30%, with the high "northern" mixture, keeping the other elements unchanged, we obtained a combined carbon content of about .30%.

The reason for this difference in carbon is obscure. Several foundrymen have attributed it to the fact that "northern" pig iron is always higher in total carbon than "southern" iron. It is a generally accepted theory among foundrymen, that the effect of silicon on graphitization is governed by the total carbon content of the iron. The higher the total carbon in the iron, the lower the silicon should be, to give the same percentage of combined carbon. It is true that iron from southern furnaces contains less carbon than iron from northern furnaces, but when the pig iron goes

through the cupola, it may either pick up carbon or lose it. In our own case, the average of the total carbon in the high "northern" mixture is not 0.10% over that of the high "southern" mixture.

I hardly believe, therefore, that the low combined carbon just mentioned can be attributed to the difference in total carbon content of the pig irons used. The fact should also be emphasized here, that molding and melting conditions in the foundry remained the same throughout, so that the difference in combined carbon can not be laid to a change in thickness of patterns or tempering of sand. We have used this high "northern" mixture for some time now, the castings having the composition, silicon 2.30%, sulphur .090%, phosphorus .70%, manganese .50% and have had fair success. Occasionally, we go back to the high "southern," high silicon mixture, for a few weeks, and there is no gainsaying the fact that the latter gives us better average results in the enameling operation. With the high "northern," low silicon mixture, most of the blistering has disappeared, but there is still an occasional epidemic of it. Every time this happens the combined carbon in the blistered piece is found to be below .15%. I have examined many blistered pieces and have noted but one exception to the above statement.

In the light of the foregoing facts one would be led to believe that a low content of combined carbon in iron would cause blistering, but it is hard to understand why this should be the case. The graphitic carbon has not been very much different in either of the two irons. Suspicion naturally attaches to graphite as the cause of blisters, because it can be burned to CO_2, a gas, and is capable of reducing certain metallic oxides in the enamel. In this case, though, the fact that there was little variation between the graphite in the two mixtures, seems to absolve it of blame. To get more light on the cause of these blisters, resort was had to metallography. We had no metallographic outfit ourselves, so that all photographs have been made by commercial laboratories.

Figures 1 to 6 all show iron which has blistered during enameling. When a piece blistered badly, it was broken up, analyzed, and a microphotograph made of the iron. It is of course understood that the piece of iron photographed had been freed from enamel, ground smooth, and etched.

Figure 1 is from a blistered sink. This specimen was etched with 10% nitric acid, which is too strong for cast iron. All other specimens are etched with $2^1/_2$% nitric acid. Figure 2 is from a blistered sink. There is very little of the blotching apparent in Fig. 1, but this was mistakenly photographed in cross-section. Fig. 3 is of the surface of a blistered tub, showing dark blotches. Fig. 4 is of a blistered sink, and gives a very good view of the dark blotches. Figures 5 and 6 are micrographs of two pieces of iron from the same pinholed tub. The exact location of a pin-

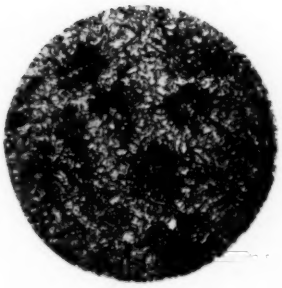


FIG. 1.
Si 2.91 P .68 CC .05
S .107 Mn .51 GC 3.11

FIG. 2.
Si 2.17 P .67 CC .12
S .110 Mn .54 GC 3.52

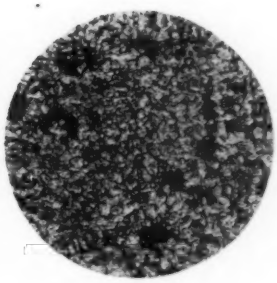


FIG. 3.
Si 2.31 P .66 CC .10
S .100 Mn .48 GC 3.50

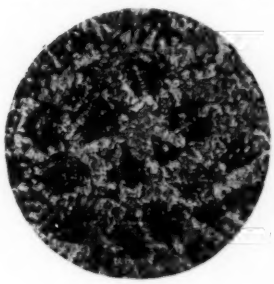


FIG. 4.
Si 2.55 P .65 CC .10
S .102 Mn .54 GC 2.76

FIG. 5.
Si 2.47 P .69 CC .28
S .106 Mn .50 GC 3.23

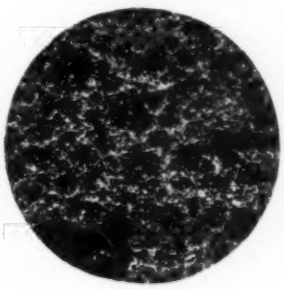


FIG. 6.
Analysis same as No. 5

FIG. 7.
Si 2.55 P .71 CC .32
S .088 Mn .54 GC 3.04

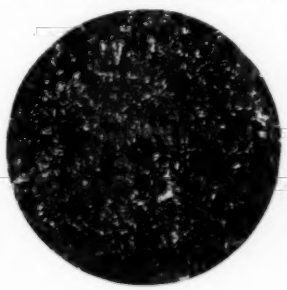


FIG. 8.
Analysis same as No. 7

FIG. 9.
Si 2.41 P .66 CC .18
S .100 Mn .50 GC 3.10

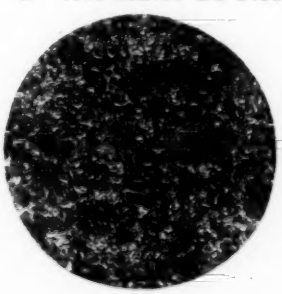


FIG. 10.
Analysis same as No. 9

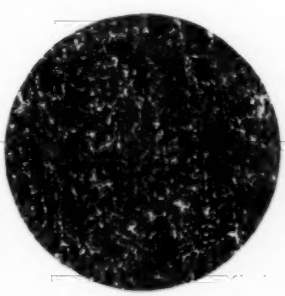


FIG. 11.
Si 2.75 P .71 CC .26
S .069 Mn .52 GC 3.06

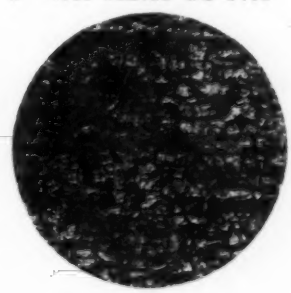


FIG. 12.
Analysis same as No. 11

hole was marked on the iron by three punch marks, and the photograph taken of this spot after grinding and etching. It might be said here that the iron underneath the enamel at these spots seemed absolutely sound to the naked eye. These two micrographs bring out the blotches very clearly.

These micrographs are all typical. Whenever this general blistering takes place, and a piece of iron which has blistered is ground, etched and photographed, the characteristic dark blotches appear in the photo. No metallographist has been able so far to tell me what these blotches are. They evidently have a direct connection with the blisters. When we can discover what they are, we will be a long way toward solving the difference between "northern" and "southern" iron.

This seems to be entirely a surface phenomenon. Whenever a micrograph is made of a cross-section, the blotches do not appear, even though the same piece shows them at the surface. Also, if a piece which has blistered during enameling, has the enamel knocked off and is sand-blasted again, it can be enameled without any blisters showing up.

Since in all of the specimens examined, except that represented by Figures 5 and 6, the combined carbon was low, it occurred to me that perhaps the enameling operation had the effect of lowering combined carbon. To settle this, several pieces were taken, broken in two, one-half enameled and the other not. Carbon determinations were made on both pieces. Analyses were also made of enameled pieces which had not blistered.

These data all indicated that no appreciable change in the carbon percentages took place during enameling.

Figures 7 and 8 represent two views of the same piece of iron. Fig. 7 was taken after enameling, Fig. 8 before enameling. This iron gave no trouble from blisters, and there are no blotches visible in either photo. I believe this could be called good enameling iron.

Another question which may be put, is whether these blotches exist in the iron before it is enameled, or are developed during the enameling. It is very hard to secure any data on this. We never know that a casting will blister until it has blistered. I have many times taken iron which I suspected, saved a piece, and enameled the rest, but have never been fortunate enough to find a piece in this way, which blistered. The nearest approach to it is shown in Figures 9 and 10. Fig. 9 is an iron which I suspected. The micrograph taken before enameling shows a very peculiar structure, very close grained, apparently. This piece when enameled had a very slight tendency to blister. Its structure after enameling is shown in Fig. 10, entirely different from Fig. 9, with a very slight evidence of blotches. This would indicate that the blotches are developed during enameling, but the evidence is too slight for much reliance to be placed in it.

Figures 1 to 10 all represent iron made with a cupola charge of 900 pounds scrap, 800 pounds "northern" iron and 300 pounds "southern" iron.

Figures 11 and 12 show two views of iron made with the high "southern" mixture in which the "southern" and "northern" iron weights are reversed.

Fig. 11 is the iron before enameling. Fig. 12 after enameling. There is a marked resemblance between these two, and Figures 7 and 8. Both are good enameling irons, although one is a high "northern" and the other high "southern" iron.

From the evidence of the micrographs, we doubt that combined carbon has a direct effect on blistering of enamel. Perhaps it is merely a coincidence that blisters are attended by low combined carbon. It seems probable that there is some element present in small amounts in "northern" ores, which does not occur in "southern" ores, or vice versa. The ordinary pig iron analysis only gives silicon, sulphur, phosphorus and manganese. Yet we know that the following elements are variously distributed among the different pig irons: chromium, calcium, cerium, nickel, copper, arsenic, and, no doubt, others. Might not one of these, if present in "northern" iron in appreciable amounts, have a simultaneous effect on the enamel and the combined carbon?

RUNDLE MANUFACTURING CO.
MILWAUKEE, WIS.

THE RELATIVE MERIT OF HEAT RESISTING ALLOYS FOR ENAMEL BURNING RACKS

By E. P. Poste[1]

ABSTRACT

Enamel burning racks fail by oxidation and warpage. Several metals have been studied with regard to oxidation and warpage at a temperature from 1700° to 1800°F. These metals are listed in the order of increasing warpage and increasing oxidation. Actual data is given and comparisons are made by means of a chart. Conclusions are drawn in terms of the choice of rack material for burning heavy and light ware.

Introduction

The troubles resulting from the oxidation and warpage of steel burning racks have caused enamelers to become interested in the various heat resisting alloys that have more or less recently come on the market. In view of the fact that in general these materials are high in price as compared with steel or cast iron, the question that naturally arises is, will it pay to invest the greater amount of money in racks of heat resisting metal in return for the longer life and better ware to be obtained. An effort to answer this question in a general way is the basis of this record.

There are two prime factors that contribute to the failure of a burning rack; warpage and oxidation. In general the former is a more serious trouble with heavy racks supporting large ware and the latter is more to be considered in the case of lighter racks. It was necessary therefore to study the action of the metals as to both of these properties at furnace temperatures.

Experimental

The following materials have been included in the comparisons which have been made: Basic openhearth steel, cast steel, cast iron, calorized steel, thermalloy, misco, nichrome, rezistal steel, nickel, monel metal, calite and hardite. These materials are listed by their trade names in view of the fact that they are all well-known products, the actual composition of many of which are not definitely known by the writer.

As representing fairly severe furnace temperatures the range 1700–1800°F was chosen for the tests. The atmosphere was that of a reasonably tight muffle.

In the warpage tests samples of metal 24 inches long and $^1/_2$ inch square were supported between supports 22 inches apart and placed in an experimental furnace maintained within the above temperature range. The less resistant metals sagged within an hour and were removed. Others kept their shape well after several hours. In either case the warpage was determined as sag at the middle in millimeters per hour.

[1] Received July 20, 1922.

In the oxidation tests samples 2 inches long and $^1/_2$ inch square were used. These presented $4^1/_2$ square inches of surface and weighed approximately 70 grams each. They were placed in the furnace and removed at certain intervals. After cooling they were lightly pounded with a hammer to remove loose scale, it being assumed that in ordinary use racks would be punished mechanically so as to remove the majority of the loose scale. The samples were then weighed and returned to the furnace. A given sample was discontinued after it had shed a heavy coat of scale representing a considerable percentage of the weight of the piece.

Results

The results of the tests are shown in the following tables. In either case the metals are given in the order of their decreasing resistance. Warpage is expressed in millimeters sag per hour. Oxidation is expressed as change in weight from the original in units of one gram.

TABLE I

WARPAGE DATA

		Mm. per hr.
1	Calite	0.7
2	Hardite	0.7
3	Nichrome	1.0
4	Nickel	1.4
5	Rezistal	1.8
6	Thermalloy	2.5
7	Misco	3.5
8	Monel metal	4.5
9	Cast steel	5.0
10	Calorized steel	19.0
11	Steel (BOH)	22.0
12	Cast iron	101.0

TABLE II

OXIDATION DATA

Time—Hrs.	2	5	7	24	75	100	150	215	260
1 Thermalloy	0.00	..	+0.01	..	0.00	..	−0.02	0.00	−0.01
2 Hardite	+0.02	+0.03	..	+0.01	..	−0.01	..	0.00	−0.03
3 Nichrome	+0.01	..	+0.02	..	+0.02	..	−0.03	−0.03	−0.07
4 Rezistal,	0.00	..	0.00	..	−0.07	..	−0.33	−0.46	−0.21
5 Calite	+0.01	0.00	..	−0.03	..	−0.37	..	−0.41	−0.67
6 Nickel	+0.04	+0.10	..	+0.36	..	+0.53	..	−4.78	
7 Misco	+0.02	..	−0.07	..	−2.20	..	..	..	..
8 Calorized Steel	+0.01	..	+0.30	..	(a)	..	..	..	..
9 Monel Metal	−2.67	−8.49	..	..	..	..	..	..	..
10 Cast Steel	−3.75	−8.78	..	..	..	..	..	..	..
11 Cast Iron	−3.90	..	..	..	..	..	..	..	..
12 Steel (BOH)	−4.75	..	..	..	..	..	..	..	..

(a) One end of the bar was exposed steel. It shed a coat of scale at 75 hours. Much of the recorded change in weight was probably due to oxidation at the end. However, at 75 hours the calorized surface had blistered badly indicating a very immediate failure.

Conclusions

To facilitate an interpretation of the above data the values are plotted on Figs. 1, 2*a* and 2*b*.

In Fig. 1 the metals fall in three rather distinct classes as to their warpage at furnace temperatures. The first 9 can be considered as very good

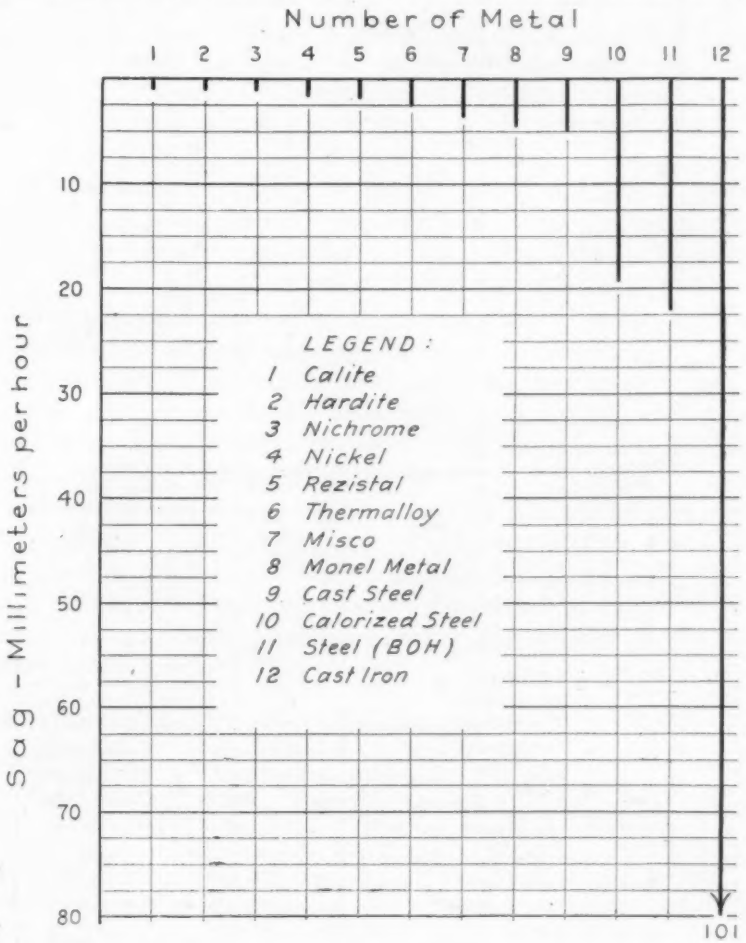


FIG. 1.

in their resistance to warpage; Nos. 10 and 11 as fair; and No. 12 as very poor.

In Fig. 2*a* the metals group themselves in three general classes. Nos. 1 to 5 can be said to have good heat resistance; Nos. 6 and 7 fair heat resistance; and Nos. 9 to 12 poor heat resistance. The exact location of No. 8 is indefinite in view of the facts stated in the footnote of Table II.

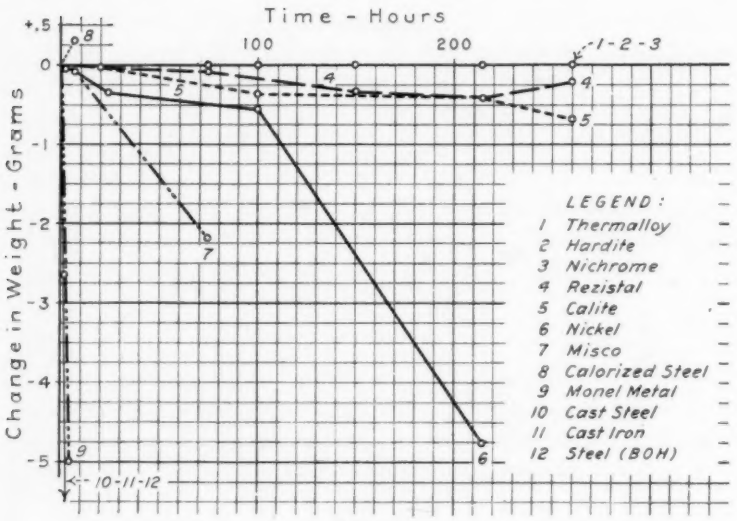


FIG. 2*a*.

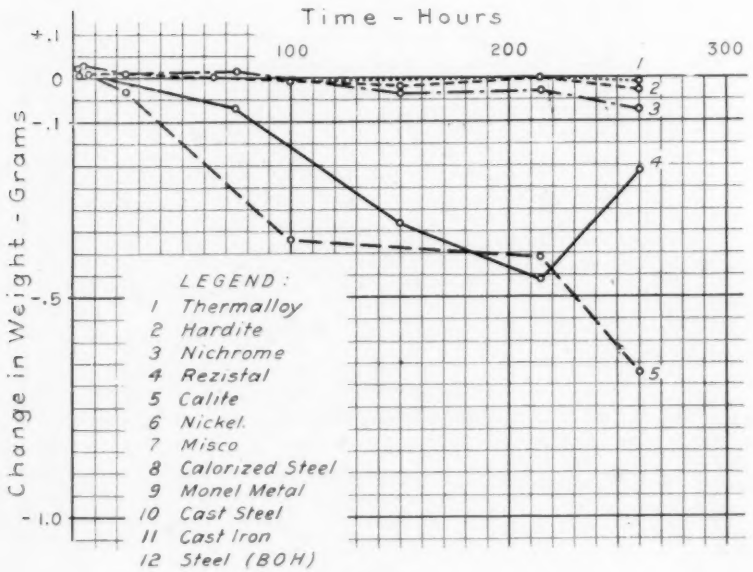


FIG. 2*b*.

Metals 1, 2 and 3 are of such high resistance to oxidation that they do not show up clearly on Fig. 2*a*. It will be noted that the values for 10, 11 and 12 are entirely beyond the range of the chart.

In Fig. 2*b* are plotted the metals which may be classed as highly resistant to oxidation. It will be noted that Nos. 1 and 2 are essentially the same,

while No. 3 is definitely of lower resistance. The relative position of Nos. 4 and 5 is a matter of some doubt. The final heating apparently produced a rather severe oxidation on No. 4 which would have undoubtedly been followed by a considerable loss in weight, had another heating period been involved. Perhaps it may be concluded that Nos. 4 and 5 are of practically equal resistance to oxidation.

As a general statement of the points brought out in this study, it may be said that cast steel and all of the metals appearing above it in Table 1 show a reasonably satisfactory load carrying quality at furnace temperatures. With higher temperatures it is probable that the difference between cast steel and the stronger materials would become more pronounced.

As to resistance to oxidation it is obvious that cast steel is considerably better than steel and some better than cast iron. Only the metals included in Fig. 2*b* can really be considered as highly resistant to oxidation however.

The matter of the choice of a material to use in a burning rack would undoubtedly depend upon whether warpage or oxidation was the cause of greater difficulty. If warpage were the chief source of trouble the use of cast steel might be the most feasible procedure; on the other hand, if oxidation were the chief objection to be overcome it would undoubtedly be necessary to resort to one of the metals covered by Fig. 2*b*.

No effort has been made to include in this report the relative costs of these materials. Undoubtedly some of the more expensive ones would be quite out of the question for heavy racks, but quite feasible for light racks. The matter of cost can be easily determined by interested parties by communicating with the people putting the different alloys on the market. They are as follows:

Calorized steel	Calorizing Company of Pittsburgh, Pittsburgh, Pa.
Thermalloy	Electro Alloys Co., Elyria, Ohio.
Misco	Michigan Steel Casting Co., Detroit, Mich.
Nichrome	Driver Harris Co., Harrison, N. J.
Monel metal	International Nickel Co., New York, N. Y.
Rezistal	Crucible Steel Company of America, New York, N. Y.
Calite	Calorizing Company of Pittsburgh, Pittsburgh, Pa.
Hardite	Hardite Metals, Inc., New York, N. Y.

RESEARCH LABORATORY
ELYRIA ENAMELED PRODUCTS CO.
ELYRIA, OHIO

Discussion

BY M. E. MANSON:[1]—Mr. Poste's paper on this subject was especially interesting to me as I had done a small amount of work along the same lines at the time of the St. Louis meeting.

[1] Received September 8, 1922.

At that time we had tried out several metals, testing only for resistance to oxidation and had found Thermalloy to be the only satisfactory one. Since then we have installed a set of Thermalloy bath tub grates, which have been continuously in a muffle at 1700 degrees F. So far they show no warpage, and practically no oxidation.

Laboratory tests have shown, however, that this alloy oxidizes rapidly at 2000 degrees F. On the other hand, two small samples of Calite, which Mr. Poste mentions, have shown practically no oxidation at 2000 degrees F. The manufacturers of Calite claim that it will withstand temperatures up to 2372 degrees F.

With such a metal available, at a reasonable price, it is possible that the day is not far distant when we will see enameling muffles built with metal bottoms.

Racks of a heat-resisting metal, which will neither oxidize nor warp, will be of great value in the sanitary enameling industry. They will not only show a lower cost per hour of service, but will lessen the rejections of warped ware, caused by warped racks.

THE CAUSTIC CALCINATION OF DOLOMITE AND ITS USE IN SORREL CEMENTS[1]

By G. A. Bole and J. B. Shaw

ABSTRACT

A method for calcining dolomite in which the pressure of carbon dioxide is controlled is described. Less than $^1/_2$ of one per cent of lime is liberated. Material was calcined in ton lots using external heating. Two types of retort were used: wrought iron and fire clay. Floors were laid from the material so calcined and physical tests made on the calcine to determine its availability as a stucco material.

The effect of time, temperature, and pressure of carbon dioxide upon three types of dolomite is brought out.

Dolomites are either double salts or solid solutions or mixtures of the two.

The effect of lime and silica is pointed out.

Dissociation, tensile strength, volume change, time of set, and weather test data are given.

Introductory

During the past few years the demand for a properly calcined caustic magnesia for use in the building industries has increased many fold. The oxide is used in two general ways: First, mixed with from 20 to 40 per cent of filler (asbestos, wood fiber, ground cork, etc.) and appropriate coloring oxides it is made into a composition flooring; second, mixed with 50 to 60 per cent sand and 20 to 30 per cent silex it makes an excellent stucco material. The general practice is to mix these compositions with sufficient 20 to 22° Bé $MgCl_2$ to spread properly when an excellent cement results.

A rather pure magnesite is necessary to produce a satisfactory material using the present burning practice due to the fact that all carbonates present are decomposed. Free lime even in amounts under 2 per cent is detrimental to the life of an oxychloride cement and in quantities over 3 per cent causes early disintegration. With this thought in mind and in view of the fact that high magnesia ore is not found near the centers of consumption, investigations were undertaken by the authors[2] to determine whether or not ore low in magnesia and high in lime, such as the dolomites, could not be used for the purpose. It is evident then that ores high in calcium carbonate must not be burned in such manner as to liberate free lime.

Effect of Time, Temperature and Pressure

Since the pressure of carbon dioxide in equilibrium with calcium oxide and calcium carbonate at temperatures as low as 650°C as shown by Johnston[3] is appreciable, it is evident that it is impossible to burn a dolomite at this temperature in any of the kilns in use at the present time for

[1] Received April 25, 1922.

[2] Shaw and Bole, *Jour. Amer. Ceram. Soc.*, **5**, 311 (1922).

[3] Johnston, *Jour. Amer. Chem. Soc.*, **32**, 938–46 (1910).

burning magnesites, without liberating lime. The present general practice with magnesites is to burn in an updraft kiln, only a small amount of the present production coming from rotary kilns.

Aside from the above considerations there are two objections to burning the ore at a temperature as low as 650°C. First is the consideration that cements made from ores burned below 700°C are not as satisfactory as those made from an oxide burned between 700° and 800°C. This is not a generally recognized fact and the explanation is not clear. The cause should be investigated. An oxide calcined at 725°C or thereabouts seems to have different physical characteristics from that burned at either a higher or lower temperature. Illustrative of this fact, the following table shows the effect of temperature of calcination on a magnesite low in lime used in a stucco mix. The same relation was later found to hold when using dolomite mixes. (See Table V.)

TABLE I

	650°C	700°C	750°C	850°C
Time of set	$4^1/_2$ hrs.	3 hrs.	$3^1/_4$ hrs.	5 hrs.
Tensile strength (24 hours)	350	480	500	450
Weathering (per cent of original strength recovered)	63	80	80	72

The cement, the physical characteristics of which are given in the above table was of a (1 MgO-2 silex-5 sand) stucco mix, made up with 22° Bé $MgCl_2$ solution.

The time of set was in all cases determined by the Gilmore needle.

The weathering tests consisted of allowing the tensile strength briquettes to age 14 days and taking an average of the breaking strength of three briquettes as the dry strength. Six briquettes were then soaked in water three alternate days (24-hour periods), and three of the six broken wet. The others were allowed to dry out for two days in normal air and then broken. This average divided by the average dry strength at 14 days was taken as the recovered strength indicated in Table I.

The second disadvantage referred to is the time element in burning. Some dolomites will calcine very much more quickly at temperatures below 750°C than will others. A study was made of this feature of the burning problem with the results indicated in Figure 1. A sample of 0.5 grams under one atmosphere of carbon dioxide was heated in a small quartz side delivery tube in an electric furnace at the rate of 1° per minute until a temperature of 950°C was reached. The evolved carbon dioxide was collected over mercury in a graduated cylinder and the volume of gas evolved at each temperature observed.

A distinct lag appears in a time-temperature curve at 750°C due to the endothermic reaction $MgCO_3 \longrightarrow MgO + CO_2 - X$ calories in the case of

dolomite No. 3, but No. 1 shows no distinct break. Bleininger and Emley[1] found this same break, but do not point out that it holds for only one type of dolomite.

Dolomite No. 1 was of the dense variety, No. 2 finely crystalline, and No. 3 was a highly crystalline stone. When later tried out in a semi-commercial way it was found that No. 1 could be calcined advantageously at 650°C, while No. 3 dissociated so slowly below 750°C, that it was not a commercial proposition to calcine below that temperature. It so happened that No. 3 was the most desirable one of the three on account of its pure white color and the ease with which it could be milled. The chemical analysis of the above mentioned ores indicated the following compositions:

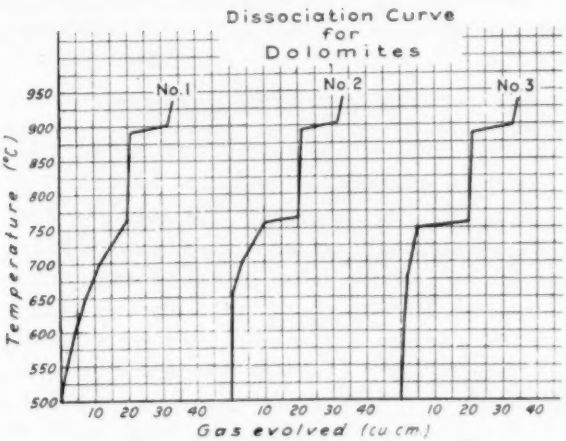


FIG. 1.

TABLE II

	No. 1	No. 2	No. 3
$MgCO_3$	39.40	46.20	43.32
$CaCO_3$	59.10	53.60	55.21
SiO_2	.35	.25	1.00
R_2O_3	.82	.65	.46

In light of the above data certain dolomites, it would seem, can be considered to be solid solutions from which $MgCO_3$ separates and dissociates progressively as the temperature is raised—CO_2 pressure being held constant—while others would seem to be a double salt with a decomposition temperature of 750°C, while still others are a mixture of the two.

The above considerations are only tentative, but seem to explain this peculiar behavior of the dolomites better than any suggestion yet offered. The whole question is to be attacked microscopically with phase-rule interpretation.

[1] *Trans. Amer. Ceram. Soc.*, **13**, 618 (1911).

Effect of Silica

It was further found that not all dolomites would make up to a satisfactory cement even when burned under the most favorable conditions of temperature—time—pressure. The unsatisfactory stones were found to be all high in silica. The analysis of a stone burning to a particularly unsatisfactory oxide was as follows:

CaO	MgO	SiO_2	R_2O_3	L.O.I.
29.15	20.00	6.10	.55	44.50

This stone was classified by the quarrymen as a water lime. Whether there is a calcium silicate formed at such a low temperature (under 850° C) seems to be problematical, but worthy of investigation. We have not been able to make a satisfactory cement from any ore containing more than 4 per cent SiO_2.

Method of Burning

The calcination of the ores was carried out in two different types of retorts; the chamber containing the ore in the one case being of wrought iron and in the other of a fire clay body. The gas-tight chamber containing the ore was so constructed as to give perfect control of the atmosphere within. A tube leading from the retort beneath a water seal kept the pressure of the carbon dioxide inside the retort at one atmosphere. The seal indicated when the calcination was completed by a slowing down and final cessation of evolved gas. The retort was heated externally by natural gas in a suitably constructed furnace. The temperature of the furnace was carefully regulated within 25° of any desired temperature. The two calcining chambers had a capacity of one-half and one and one-half tons, respectively. The time necessary for the calcination in both cases was from 10 to 12 hours.

In all about 15 tons of material was calcined at a temperature varying from 700 to 800°C. Floors were laid using this material together with suitable filler. The material set up in four to five hours too stiff for further troweling, was in use the second day after laying. These floors have been in service two years and are in perfect condition and giving good satisfaction.

Stucco

Realizing that an ore containing, when burned, only 28 per cent of MgO and as much as 70 per cent limestone was better suited for a stucco material than for flooring, where in many cases as high as 50 per cent of MgO is preferred in the final composition, experiments were undertaken to determine whether this material would make a good stucco which would resist the weather.

The weather test outlined above was applied to two dolomites widely different in physical characteristics. No. 1 and No. 3, whose calcination curves are shown in Table I, were chosen, together with a so-called Canadian magnesite with the following composition.

$MgCO_3$	$CaCO_3$	SiO_2	R_2O_3
78.05%	20.10%	1.60%	.70%

The ores were calcined at 750°C in a retort as described above and made up into a stucco mix. The results of the weathering tests are shown in Table III.

TABLE III

	No. 1	No. 3	No. 4
Tensile strength (14 days)	630	825	538
Wet strength	330	300	234
Recovered strength	486	410	535

The recovered strength of No. 4 was remarkable, No. 1 very satisfactory, while No. 3, in spite of its high dry strength, showed an unsatisfactory recovery.

The recovery of No. 1 and No. 4 is superior to 80 per cent of the "magnesite oxides" at present on the market made up in similar mixes. No. 3 would probably prove to be an unsatisfactory stucco material.

Overburning

It was thought desirable to determine whether the portion of the sample in direct contact with the hot walls was being overburned, so an inside cylinder was fixed within the retort in such a manner that the portion in direct contact with the hot walls could be removed separately from the portion in the center of the retort. A sample was calcined at 750°C in this manner and the free lime determined by the ammonium chloride-potassium permanganate titration process. It was found that the difference in the free lime was well within the experimental error inherent in the method. The amounts found were, respectively, 0.36 and 0.42 per cent. Physical tests were run on the two samples with the following results.

TABLE IV

		Sample from inner tube	Sample from outer tube
Time of set (final)		4 hrs.	4 hrs. 10 min.
Linear change		0.10%	0.12%
Tensile strength (averages)	24 hrs.	500	520
	14 days	825	800
Weathering (recovery)		60%	62%

From the above data it is evident that there was no overburning in any part of the retort.

Temperature Range

Since, as previously pointed out, it is more economical to calcine a dolomite at comparatively high rather than at low temperature, it was thought desirable to know the burning range of any given ore. Accordingly, three 20-pound samples were calcined at temperatures ranging from 700° to 825°C. The following table records the results of the tests:

TABLE V

		700°C	750°C	825°C
Time of set		4 hrs.	4 1/4 hrs.	5 1/2 hrs.
Tensile strength lbs. per sq. in. (averages)	24 hrs.	480	520	470
	14 days	765	800	805
	28 days	890	910	875
Linear change	At final set	Nil	Nil	.05
	48 hours	.05%	.06%	.12%
Weathering lbs. per sq. in.	Dry strength	765	800	805
	Wet strength	280	270	250
	Recovered strength	400	380	310

While the burning temperature did not show great effect on the tensile strength, it did indicate that the lower temperatures gave a better product, as indicated by the change of volume, time of set, and somewhat less clearly, in the weather tests. In no case was there more than 0.45 per cent free lime found.

Whether these results will be borne out in practice can only be proven by time, but the indications would point to the use of properly calcined dolomite as a source for magnesium oxide used in the stucco trade.

Summary and Conclusions

It has been pointed out that: (1) Dolomites can be calcined in such a way as to liberate the magnesium oxide and leave the calcium carbonate undecomposed by controlling the pressure of the carbon-dioxide.

(2) Dolomites having practically the same chemical composition may differ radically in physical constitution, and an explanation of the cause is offered, *i. e.*, that some dolomites are solid solutions and others double salts, while still others are a mixture of the same.

(3) The best temperature for calcining ore to be used in a sorrel cement was found to be approximately 725–750°C.

(4) Ores high in silica make an inferior cement.

DEPT. OF CERAMICS
N. Y. STATE SCHOOL OF CERAMICS
ALFRED, N. Y.

NOTE ON LADLE BRICK[1]

By D. A. Moulton

ABSTRACT

Review of Literature on Ladle Brick.—(1) American ladle in which it is stated no chemical reactions occur; (2) English ladle in which four or five chemical reactions occur simultaneously.

Fusion Point of Ladle Brick ranging from cones 17 to 30 depending on behavior of clay at temperatures below the fusion point.

Process of Manufacture.—Two processes, namely dry press and stiff-mud with preference for dry press. Modification of standard refractories is suggested.

Review of Literature on Subject

Refractory work[2] in a steel department begins with the lining of ladles used in transporting the molten metal from the blast furnace to a metal mixer, Bessemer converter, or to open hearth furnaces. A practical lining for such ladles consists of brick covered with a rammed mud cake made of six parts fire-brick grog, two parts clay, and two parts silica stone. This cake will last forty-eight hours continuous use, possibly longer, and comes out with the "skull." The temperature of blast furnace iron running into ladle is 2850°F, hence the lining must be refractory enough to easily withstand this temperature.

A charge[3] of forty tons of H. E. shell steel poured into a ladle with two casting nozzles left only fifty-six pounds or less of "skull" when the ladle was emptied. This ladle was unevenly preheated, and four or five reactions may be going on simultaneously in such a ladle, these reactions being exaggerated by the unevenly-preheated ladle.

The reactions are oxidation, deoxidation, colloidal segregation, cooling, and definite change of phase (skull formation). This steel contained oxygen when tapped and had oxygen added to it by the ladle lining, so a test was run to determine the quantity of gas evolved by the ladle brick and the quality of the gas, when the sample was at red heat in vacuum by a Sprengel pump.

The following is chemical analysis of this brick lining:

Loss on ignition	0.20	
SiO_2	54.00	One hundred grams of this brick
Al_2O_3	38.78	sample only gave off 2.45 cc. of
Fe_2O_3	5.28	gas at 767 mm. at 15°C.
CaO	0.30	
KNaO	1.10	

[1] St. Louis Meeting, March 1, 1922.

[2] "Refractory Linings and Materials" by J. W. Haulman, *Blast Furnace and Steel Plant*, **5**, 159 (1917).

[3] "Properties of Refractories Used in Steel Production" by Allene Reynolds, *Trans. Ceram. Soc.* (Eng.), **17**, 385 (1917–18).

Clays Used in Ladle Bricks.—The ladle bricks made in this country are manufactured from No. 2 and No. 3 fire clays of which following analyses are typical.

	New Brighton Lower Kittaning	New Jersey	Aetna Mine W. Va.	Kentucky	Iowa	English
SiO_2	62.89	67.26	57.52	60.52	62.49	61.88
Al_2O_3	21.49	23.36	21.76	20.99	24.42	22.37
Fe_2O_3	1.81	1.63	3.41	3.41	1.45	3.00
CaO	0.38	0.25	0.60	0.21	0.29	0.32
MgO	0.56	...	0.88	0.14	0.08	0.44
Alkalies	0.29	0.65	3.60	2.85	2.41	NaO 0.36 KO 1.42
TiO_2	1.03	...	0.83	1.10	1.19	1.14
Ignition	13.76	6.94	8.13	9.83	7.35	8.72

The range of fusion of clays used in making ladle brick and of the brick themselves runs from cone 17 to cone 30. The picture illustrates a dry press ladle brick, the upper half of which was not put into fusion furnace. The lower half was subjected to a heat treatment which caused a cone made from the same brick to fuse down. The brick was swelled some and had cracked.

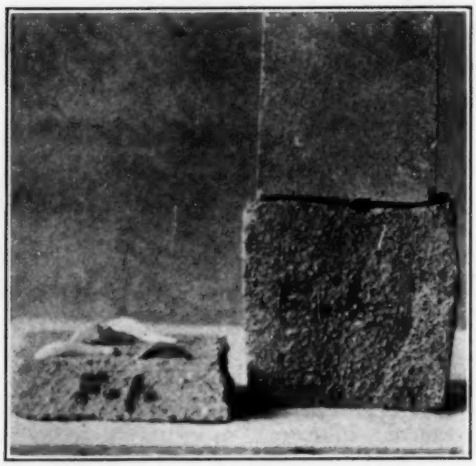


FIG. 1.

This brick in practice is giving about eleven heats with a mild steel low in carbon, using loose soil in bottom of ladle each time it is filled.[1] As high as 1000 heats can be obtained with a brick lining when the rammed clay lining is used to protect the brick.

The best ladle bricks have a fusion point of cone 26 and give 15 to 20 heats and are made without addition of any sandy material.

Methods of Manufacture

Ladle brick are made by both the stiff-mud and the dry-press process. The dry-press brick have given much better results in ladles.

Testing of Ladle Brick.—It is found that the standard tests for refractory bricks are too severe for ladle bricks and especially is this true of

[1] Information furnished by H. V. Smallwood, Purchasing Agent, Whitaker-Glessner Co., Portsmouth, O.

the slag test. The slag test, calling for exposure of five sides of the brick to the temperature of molton slag badly overfires the brick. The following heat treatment seemed to be best for slag test, using open hearth slags: Bring the kiln up to 2240°F, then put the brick into furnace; when 2350°F is obtained put slag onto the brick; hold at 2350°F for one-half hour. This produces a penetration averaging 0.15 inches for brick made of clay itself (mostly chemical solution), while in brick having an addition of sandy material, the penetration averages 0.30 inches, consisting of less chemical solution and more mechanical penetration filling very small crevices in the brick.

In testing with copper slags containing some metallic copper, the temperature of 2150°F is used, and the slag added and held at this temperature for three hours.

This copper test gives a penetration of 0.06 inch for brick of clay itself (mostly chemical solution), and 0.36 penetration in brick using sand rock with clay, this being mostly mechanical penetration.

The load test is also too severe for this class of brick.

The usual spalling test employed in testing high grade refractories, (cooling rapidly in water) is too severe. An air blast on hot end of brick gives comparative results and permits of grading of ladle brick in regard to ability to withstand spalling action.

Since large quantities of ladle brick are used every year, it is desirable to have special specified test for this particular type of refractories.

IOWA STATE COLLEGE
AMES, IOWA

I. THE USE OF PULSICHROME FROM A MANUFACTURER'S STANDPOINT

By Ernest Clark

ABSTRACT

I. Two papers setting forth the advantages of the pulsichrometer for applying glazes, followed by discussions. In the pressing room the use of the pulsichrometer gives a uniform appearance; rapid application and pleasing effect in one operation in slipping department; eliminates the necessity for re-burns in the kiln department; handled with greater speed in the fitting department.

II. The advantages of the pulsichrometer *versus* the old method of applying glazes are the better production of colors and elimination of the "human element." Closer coöperation is expected between the terra cotta manufacturer and the architect.

The advantages of the use of pulsichrome are many, and, so far, its disadvantages have to be discovered. As different experiments are tried from time to time, newer and better results appear, and it would seem as though a promising future lies ahead for the terra cotta manufacturer in this new method of applying the finish to the surface of the ware.

The first immediate benefits of the use of pulsichrome become apparent in the pressing room. The work turned out by a novice in the art of pressing after it has been sprayed by the pulsichrometer, shows as good a result as that turned out by a more experienced hand. The only necessities are that the ware be pressed out. The only finishing practically necessary is to remove the seam of the mould, and of course to see that the piece is straight and true. The pulsichrometer gives the ware a very uniform and pleasing appearance, which is all the more emphasized when the terra cotta is set, and the building completed.

In the slipping department further benefits are to be found. Under the old method of working, the slip, or enamel, was applied with an air brush and it was very essential that the workmen handling these air brushes should be highly proficient and skilful, so as to know when they had just the right amount applied. Again only one color could be applied at a time. With the pulsichrometer, any ordinary intelligent workman can be taught in a very short time to obtain a good result, for the machine gauges the amount of enamel applied, and, at the same time, the desired effect is obtained by the regulation of air pressure, thereby making the general effect consistent and similar throughout. Whereas it formerly took several operations to arrive at the final result in the slipping department, the pulsichrometer now obtains a better and more pleasing effect on one operation and the application is as rapid as with a plain enamel coating.

The greatest advantage of the pulsichrometer, however, is to be found in the kiln-burning department. Experience has shown that pulsichromed ware comes from the kiln 100 per cent good, making it unnecessary to

have any re-burns at all, therefore delivering it to the fitting department, the job complete, and at a given time. Formerly, as is well known with straight enamels, the kiln burning department often got results which were unexplainable despite the fact that the greatest care and attention had been exercised in the burning of the kilns. There seems to be an unlimited leeway allowable in the burning of the pulsichromed ware.

In the fitting department the ware which has been under the pulsichrometer can be handled with greater speed in the assembling of the work than was formerly the case due to the fact it is unnecessary to shade the ware. Even in cases where a piece of ware has become fire-flashed all that is necessary to do is to sand-blast the surface lightly, and the effect of the whole becomes quite uniform. There is no such a thing as a crazed or blistered piece where pulsichrome has been used, and spalling is unknown. Pinholes will occasionally appear, as of yore, but the effect of the application of pulsichrome is such that the pinholes are neutralized to such an extent that the general aspect of the surface is not impaired thereby.

Minor chipping sometimes occurs in transit, and this is less noticeable on the building than in plain colors. In putting polychrome colors on pulsichrome pieces it is unnecessary in most cases to do any brushing off, which causes considerable saving in this department.

THE AMERICAN TERRA COTTA AND CERAMIC CO.
TERRA COTTA, ILL.

II. PULSICHROMETER vs. OLD METHOD OF APPLYING GLAZES

BY L. M. MUNSHAW

For some time it has occurred to most of us who are striving to match or produce colors for terra cotta, that there must evolve some method of producing color and texture other than the old way of taking new colors and working them in with other colors to get a desired effect.

Many colors produced by the old method were obtained by the application of several speckles, sometimes as many as four, upon either the body or some undercoating. It required much work for the laboratory to prepare the numerous colors, as well as a great amount of work in their application. This application required a number of men experienced and proficient in this line of work because the amount of colors applied depended largely upon the pressure exerted by the thumb and fingers of the men on the hose carrying the enamel or slip. In working around ornament it was necessary to keep the hose well pinched together so as not to get too much color on the ornamental material. With the greatest of care considerable variation in color resulted, even at the best. This was inevitable because the hand naturally became weaker as the day progressed, allowing more enamel to flow through the hose than at the earlier part of

the day. Then again the personal element had to be contended with, for no two workmen handled the hose in the same manner or with the same maintained finger pressure.

Now, by the use of the pulsichrometer, all this guess work and undetermined conditions are done away with, and as in modern machinery, the matter of "human equation" does not enter into the operation. Air pressure, size of hose, construction of nozzle plates, speed of machine, etc., are all recordable conditions and determine the tone color and texture of the result. Once a color is established, with this precise data at hand, it can always be duplicated with a certainty not reached by old methods, and the knowledge and control of these conditions make it possible to reduce the samples necessary to run.

To obtain a desired color and effect for matching a certain brick, stone, or granite, we take two or three of their predominating color tones and apply corresponding slips or enamels simultaneously with the pulsichrometer. In every case the result is a color that matches or harmonizes. In fact, so acceptable have been the results obtained by the pulsichrometer, that clients now ask for colors that *harmonize*, rather than for those which match or imitate.

Discussion

MR. TUCKER:—Do you vary your speed?

MR. ERNEST CLARK:—In regard to varying the speed, I think there were some machines put out which ran faster than the uniform speed, but I think now they are all the same. Ours all run practically on the same speed.

Mr. MCMICHAEL:—I think we began using the pulsichrometer before the motor was developed up to the point it is now. We had difficulty with this motor, and since we were several thousand miles away, it was difficult to send for parts. We experimented with a flexible shaft on this motor. The first two shafts twisted in two pieces in about five minutes, but we finally secured a flexible shaft with which we had no trouble.

MR. ALBERY:—Our experience with the pulsichrome machine has been the same as Mr. McMichaels's. We had been having a lot of trouble with the mechanical operation of the thing, probably due to the current that we used. The best machine that we have had is a one lung machine out of which we took one of the coils. Since then it has been running fine.

MR. W. D. GATES:—Using this machine has cured many troubles we had in the old process in which the application varied not only when applied by different individuals but with the same man from day to day, for as his mood changed so did his manner of application.

A record of the setting of the machine can be accurately reproduced even after the lapse of a long interval.

Then too, the colors being all applied at once, all of the same consistency and wet, not only give spots of each color, but in their mingling to an extent give other tints; in the many cases even new shades of color. Its use, has saved us money, labor and annoyance and furnished great satisfaction to our customers.

MR. GLADDING:—In connection with this matter I would like to say that in the past year we have just completed two jobs using about a thousand tons of pulsichrome. We had very good results by using two glazes, one a brown, and the other a cream color, one containing tin oxide and the other containing chromium. The combination of these glazes where they happened to be built up in just the right combination will give a splash of pink, make a three color combination giving a very delightful effect. I was very much pleased with it.

MR. ALBERY:—I believe that several of the benefits claimed by Mr. Clark are benefits that are to be derived from the use of any mottled color regardless of the methods of application. Very little finishing is necessary on well-dressed terra cotta that is to receive a mottled color. Any mottled color will "pass" with a small variation which would ordinarily be objectionable in a plain color. Slight defects, such as pinholes, small blisters, small chips, etc., are not as noticeable in a mottled color as in a plain color.

I believe that the real benefits in the use of the pulsichrome machine are: (1) The new color effects made possible by its use. (2) The saving in the spraying department, where the work that would ordinarily require three experienced men can be done by one man of less experience.

MR. H. E. DAVIS:—I can agree with Mr. Clark that pulsichrome effects a saving in the pressing and finishing and also in the fitting departments. But as Mr. Albery has brought out, this is likewise true of any mottled color. However, there is one statement to which I must take exception: "There is no such thing as a blistered piece where pulsichrome has been used, and spalling is unknown." There is no machine, nor will there ever be one which will prevent blistering, as that is something which is entirely beyond the scope of any spraying apparatus.

As for spalling, I should like to ask Mr. Clark how he figures that this will be cured by the use of the pulsichrometer. As spalling does not usually become evident until a few years of weathering have had their effect, it may be quite possible that to date, spalling on pulsichromed terra cotta "is unknown," but I see no reason why, in the next few years, it may not be brought to light the same as on any of the usual enameled ware.

BY F. B. ORTMAN[1] (Communicated):—It would be very interesting if we could add to this series of papers on the pulsichrometer, a paper dealing

[1] Received Aug. 31, 1922.

with pulsichrome material from the architect's point of view. There is no doubt that pulsichrome material appeals instantly to a large majority of the architects who are anxious to develop something new in color and texture effects for building façades.

A very considerable proportion of the architects, at least those doing business in Southern California, frequently specify pulsichrome material and are already sufficiently well informed as to the character of the surface and texture produced as not to be satisfied with mottled and granite textures formerly produced by the method of superimposing one color upon another.

The force with which the particles of slip or glaze strike the piece is undoubtedly one of the most important features of the machine, as it results in a blending of colors and an enlargement of scale which can not be produced by any other method known to the writer.

The soft feeling produced by carefully selected colors applied with the pulsichrometer is eagerly sought after by most present day architects. Furthermore, the distinctive effect produced stamps the material at once as terra cotta being used entirely on its own merits, neither imitating other material nor capable of being imitated in other material. On the other hand, there are still some architects who do not take to the pulsichrome effect considering it somewhat of a fad and in keeping with the "jazzy" tendencies of the times, and insist that in a very short time architects will soon revert to the plain slips and glazes. Whether they will or not lies very largely with the manufacturers themselves. If they put out samples and material in clashing colors and loud unpleasing contrasts, pulsichrome materials will very soon be in discard. Too much care can not be exerted on the part of the manufacturer in submitting only those pulsichrome effects which are made up of pleasing natural blends of tints and shades rather than riotous hodge-podges of color.

Another objection sometimes raised is that the pulsichrome material prevents the proper registration or reading of the ornament. This, the writer believes to be more fancied than real. If the color contrast is not severe and if the modeler in executing this work bears in mind that the same is to be finished with pulsichrome material, the final result can be made even more pleasing by being rendered soft and harmonious. Here again the manufacturer must take a great deal of responsibility in not permitting pulsichrome finishes to be used on enrichment not adaptable to such a finish.

As regards the practical considerations surrounding the use of the machine in the plant, the writer's experience with the machine would not justify him in agreeing with all that has been said by the authors of these two papers. The machine has some very serious faults, the chief of which seems to be the unreliability of the small motors with which they are

equipped. In our experience, it very rarely happened that the machine would hold up in continuous operation for very many days without having to be taken apart and rather extensive repairs and replacements made. Probably some of this trouble is due to the varying electric currents under which the machine is called upon to operate in different parts of the country, but nevertheless, this is a distinct weakness which the patentee should make every effort to overcome, in order to keep its popularity from waning.

The writer does not agree with Mr. Clark that the pulsichrometer makes the work pressed by a novice the equal of that pressed by an experienced man. It is true that very much less finishing is required when the pulsichrometer is used, but nothing in the way of surface finish can correct or cover up poor pressing.

Furthermore, in our experience, there has been no saving in time whatever in the spraying of pulsichrome material over the old method of spraying mottled ware, due to the fact that the time saved in the application of three slips simultaneously is considerably more than lost by the breakdowns that are constantly occurring in the pulsichrometer itself.

Neither can we agree with his statement that "pulsichrome ware comes from the kiln 100 per cent good, making it unnecessary to have any re-burns at all." It is true that the nature of the surface permits the use of considerable material having minor glaze defects such as slight crawls, pinholes, etc., that would not be permissible in plain ware, but there is still as much tendency toward variation in shade due to kiln burning conditions in pulsichrome ware as in any other ware, and this variation is always sufficient to make it absolutely essential that a certain amount of shading and selecting be done in the fitting department.

In general, the writer would say that the advent of the pulsichrometer was a distinct addition to the terra cotta industry in that it has enhanced the architects' opinion of the material by making it possible for him to secure effects not hitherto available. It has also helped in a small measure to solve some of the manufacturers' problems in getting out certain classes of work, but like most new machines, there is still a great room for improvement from a mechanical standpoint, and even when operating efficiently, it can by no means be considered a panacea for all ills of pressing, spraying and kiln burning departments.

THE EFFECT OF SOME FLUXES ON THE ABSORPTION AND TRANSVERSE STRENGTH OF A TERRA COTTA BODY[1]

By E. C. Hill

ABSTRACT

The results show the effect on the absorption and transverse strength of a terra cotta body by the addition of various material used as possible fluxes.

Introduction

In compounding terra cotta bodies, it is customary to control such properties as shrinkage, absorption and transverse strength by varying the amount of open and tight burning clays in the body, or by varying the amounts of porous grog. When it is necessary to lower the absorption and increase the strength of a body the tight burning clays are increased or vitrified grog is substituted for porous grog. The addition of other materials to the body to accomplish the same result is not practiced to any extent. The addition of some material to act as a flux in the body might be advantageous in some cases.

A small series of tests was made, using some of the common materials which it was thought might lower the absorption and increase the strength.

Table I

No.	Composition	Linear fire shrinkage	Per cent absorption	Modulus of rupture, lbs. sq. in.
	Clay Mixture	6.43	5.15	3474
	Body Mixture (no flux)	2.34	15.97	1518
1	5% Maine Feldspar	3.00	14.68	1486
2	10% Maine Feldspar	4.01	11.69	1905
3	5% Albany Slip	3.38	15.63	1590
4	10% Albany Slip	4.12	12.90	1732
5	2.5% Powdered Glass	2.81	14.84	1489
6	5.0% Powdered Glass	3.37	12.70	1687
7	2.5% White Lead	2.44	15.79	1372
8	5.0% White Lead	2.88	15.03	1461
9	1.25% Cryolite	2.80	15.54	1339
10	2.5% Cryolite	3.39	13.41	1426
11	1.25% Whiting	3.04	15.60	1618
12	2.5% Whiting	2.57	16.77	1503
13	5.0% Whiting	2.47	17.91	1545
14	2.5% Fluorspar	2.21	17.03	1275
15	5.0% Fluorspar	2.48	16.49	1326
16	1.25% Magnesium Carbonate	2.21	16.87	1269
17	2.5% Magnesium Carbonate	2.56	17.21	1240
18	5.0% Magnesium Carbonate	1.76	17.55	1152
19	5.0% Furnace Slag	2.26	15.68	1361
20	10.0% Furnace Slag	2.60	13.45	1407
21	2.5% X Flux	2.61	14.09	1685
22	5.0% X Flux	3.44	9.55	2032

[1] Terra Cotta Division, St. Louis Meeting, Feb. 28, 1922.

The body used consisted of four clays and contained two parts of clay to one of porous grog. A sufficient amount of clay and grog for the series was prepared by grinding the clay and grog separately to pass a 16-mesh screen. Sixteen pounds of clay and eight pounds of grog were combined for each body, to which was added the flux. The whole was mixed by hand, water added and the mix thoroughly wedged.

Five trials $7 \times 3\frac{1}{2} \times 2$ inches of each body were made from which the linear shrinkage was measured. Ten trials $8 \times 1\frac{1}{4} \times 1$ inch of each body were made for determining transverse strength. All trials were fired at cone 6 in a terra cotta kiln.

The transverse strength trials were broken in an Olsen Shot Transverse Strength Machine with a 6-inch span. The cross-sections of the broken pieces were measured and the modulus of rupture calculated by the usual formula. The absorption was determined on the broken transverse strength trials, using pieces about 2 inches long. They were boiled two hours, completely immersed.

The results given in the following table are the average of five trials for linear firing shrinkage, ten for transverse strength and four for absorption.

Materials Tested

Feldspar.—Feldspar could be used as a flux in a body in amounts from five to ten per cent. Feldspars other than Maine could be had with a somewhat greater fluxing effect. Off-colored feldspars could be used for this purpose if they were finely ground.

Albany Slip.—This material is not as effective as feldspar. In these tests, it was ground to pass a 160-mesh screen. If ground finer, its effectiveness would likely be increased somewhat. It has a disadvantage of darkening the body color and increasing the drying shrinkage.

Powdered Glass.—This material is somewhat more effective than feldspar. If it could be obtained at a price that would warrant its use in terra cotta bodies, it would seem to offer better possibilities than any other material tested. It is likely that by grinding cullet or scrap glass at the plant, it would be available at a reasonable price. It would have to be ground to a fine mesh to prevent injury to workmen.

White Lead.—This material does not seem to be very active in the body, although it is an effective flux in glazes and slips containing feldspar. It would be too expensive for this purpose.

Cryolite.—This is an effective flux but too expensive for the purpose.

Whiting and Fluorspar.—Additions of whiting up to 5 per cent increase the absorption, but do not appreciably lower the strength, while additions of fluorspar increase the absorption and lower the strength. Whiting acts as a flux in glazes and slips containing feldspar.

Magnesium Carbonate.—Heavy magnesium carbonate was used. Additions of magnesium carbonate increased the absorption and lowered the strength. Magnesium carbonate is a very active flux in porcelain bodies at higher temperatures.[1]

Furnace Slag.—This material was obtained from the New England Slag Company through the courtesy of Mr. R. H. Minton. The lumps were broken up and ground to pass a 40-mesh screen. Addition of 10 per cent lowered the absorption, but did not appreciably increase the strength. Finer grinding would increase the effect of the furnace slag additions. The sample tested could not be used in a terra cotta body on account of the iron impurities, but it is said that slag free from iron, can be obtained.

X Flux.—This material was submitted for this purpose. It is a by-product containing soda, alumina, silica and about 4 per cent of iron. The composition is not known. It is very effective as a flux but could not be used on account of its iron impurities.

Conclusions

Any of the materials used that tended to flux the body would, no doubt, have been more effective if ground with the clay in a ball mill, but this method would have given a more intimate mixture than could be secured by the usual method of preparing terra cotta bodies in which the clay is ground in a dry pan.

The alkali salts probably have as great a fluxing action on terra cotta clays as any other materials that could be employed, but they can not be used on account of their tendency to form a scum on the surface of the ware. Insoluble materials, containing a considerable amount of alkali and which do not contain impurities that would discolor the ware, would appear to be the most desirable fluxing materials. In this series of experiments, these materials are feldspar, powdered glass and cryolite. The last mentioned is too expensive for this purpose. Since ordinary glass is more fusible than feldspar and contains more alkali, it would seem to be preferable to feldspar, that is if it is as economical to use.

Whether or not there is any advantage in using a flux in a body would depend largely upon the tight burning clays or vitrified grog available. Where these are available at reasonable cost, there does not seem to be any advantage in using a flux. By using a flux, however, a wide range of bodies are possible without the use of vitrified grog. If vitrified grog were to be used generally, it would be difficult likely, to obtain an adequate supply.

Conkling-Armstrong Terra Cotta Co.
Philadelphia, Penna.

[1] Riddle, *Jour. Amer. Ceram. Soc.*, **2**, 812 (1919).

Discussion

MR. C. W. HILL:—This is a subject which would seem to merit investigation. If a metallurgical flux were found which is suitable, one would of course have to be certain that its composition is fairly constant. Some fluxes vary considerably from batch to batch and trouble might arise from this source. In connection with the use of glass I wonder whether there is any danger in course of time of devitrification of the glass. If this took place and the glass were acting as a bond, the body would tend to disintegrate.

MR. MINTON:—Mr. Chairman, I thought that this by-product would be a very interesting thing to experiment upon for that reason. It would seem to me that the question of the fineness of the glass that is used ought to be considered.

MR. C. W. HILL:—Of course, glass has a strong fluxing action on clay and it is possible that the composition after firing would be so changed that the resulting product would no longer have the properties of glass.

MR. HOTTINGER:—Low-fusing clays can be used to produce denser bodies. However, they are usually red burning and will darken the bodies in which they are used. This is not always objectionable and some of these red burning fusible clays very often have a small iron content and do not color the body very much so that we have here a cheap source of material for hardening bodies. Many of these red clays have a very much lower softening point than the Albany slip clay used in Mr. Hill's experiment and will therefore have a much more powerful effect on the strength of the body. Many of the shales can be used for this purpose since they do not add any difficulty in drying or to the processing of the ware.

BY C. W. HILL:—(Communicated). From a research standpoint it would be interesting to study the effect of these fluxes on the structure of the body. Possibly this could be done microscopically. It would also be interesting to study the action of the various fluxes on the individual clays and grit in the body in a laboratory way. Some indication of the action of the flux might be determined this way.

BY R. L. CLARE:—If it were Mr. Hill's intention to lower the absorption and increase the strength by this investigation, I think it would be much more practical to use low burning clays as the flux. I have found that clays, like the Brazil, Ind. clay, when added to a terra cotta body of the eastern type and burned to cone 6, are a very effective flux. In this manner, you are not adding a foreign non-plastic substance which materially affects the plasticity and working qualities of the body. From the factory standpoint, the introduction of an artificial flux, as suggested by

Mr. Hill, is liable to have a very serious effect upon the warpage of the body during firing. If 5 per cent of such a flux were added, the grog used would have to be reduced proportionately in order to maintain the same plasticity and working properties. It is not hard to predict the result of such a change on full sized burned pieces. A serious increase in warpage is bound to occur.

CERAMIC ABSTRACTS

Compiled by the

AMERICAN CERAMIC SOCIETY

ROSS C. PURDY, Editor
EMILY C. VAN SCHOICK, Ass't Editor

ABSTRACTORS: E. N. BUNTING, W. M. CLARK, L. H. COLE, G. S. FULCHER, S. L. GALPIN, R. F. GELLER, SEIJI KONDO, A. T. MALM, R. J. MONTGOMERY, LOUIS NAVIAS, C. W. PARMELEE, C. M SAGER, JR., H. G. SCHURECHT, R. B. SOSMAN, H. F. STALEY, E. W. TILLOTSON, F. A. WHITAKER.

Vol. 1 **November, 1922** **No. 11**

Author Index[1] to Abstracts for November

Author	Number of abstract
Alger, John W.	113
Allen, Wm. H.	31
Amenomiya, Y., Kojima, K., and Ota, H.	125
Anderson, A. H.	76
Andrews, W. S.	53
Anon.	3, 5, 6, 7, 8, 9, 17, 24, 57, 89, 90, 94, 118, 152, 154, 155
Bales, C. E.	55
Bartel, P.	84
Barton, L. J.	65
Bellamy, Harry T. and Sweely, Burton T.	139
Birdsey, Chas. R.	158
Boddie, C. A.	74, 75
Bodin, V.	59
Braly, A.	49
Briggs, Wm. A.	149
Broadberry, A. E.	64
Brown, Wilber F.	131
Carstens, Alex. B.	67
Chase, Earl G.	140
Cowell, R. E.	108
D'Adrian, A. L. D.	144
Danielson, Axel	28
Davis, N. B.	41
Demuth, W.	92
De Nolly, H.	70
Dyrssen, W.	71, 77
Edgen, E. M. and C. G.	26
Editorial	88
Ellery, Edward	13
Fels, W. T.	162
Ferguson, A.	48
Ferguson, A. and Dowson, P. E.	48
Ferngren, Enoch T.	136, 141
France, Wm. A.	73
French, C. A.	78
Fuha, K.	37, 123
Fuha, K. and Yoshioka, Y.	121
Fukudo, T.	148
Funk, P.	110
Funk, W.	83
Fuwa, Kitsuzô	143
Gifford, J. W.	126
Granger, A. A.	115
Granger, Albert	54
Granger, Albert and Brémond, Pierre	35
Green, A. T.	64
Hague, Alfred G.	111
Havens, G. H.	164
Henshaw, Seth B.	132
Hess, Henry W.	117
Hirano, Kosuke	96
Hisada, Arajiro	97
Hojo, K.	38
Huges, W.	14
Hull, R. W.	79
Hunt, M. H.	91
Ihara, K.	39
Ishikawa, Jiro	20
Ishikawa, K.	119
Johnson, Henry E.	138
Jones, D. A.	63, 64
Judson, Lyman C. and Martin, Harry P.	80
Kano, Kosaburo	98
Kano, S.	151
Katada, Kinji	109
Kawamoto, Tomotaro and Kato, Gosuke	95
Keele, J.	43
Kirchner, R. E.	51
Kirk, C. J.	102
Kishimoto, K.	150
Kitamura, Y.	86
Knapp, L. F.	52
Kohl, H.	1
Kraze, F.	85
Kucera, Peter	133
La France, Richard	142
Landis, W. S.	16
Lemon, J. J.	161
Meade, Richard K.	68
Mellor, J. W.	106
Mellor, J. W., Sinclair, N. and Devereux, P. S.	107
Miller, T. F.	153
Miller, Wm. J.	134
Momoki, S.	62, 87
Mori, S.	145, 146
Morimoto, K.	10
Murakoshi, Eizaburo	100
Myers, Hubert A.	130
Nakahara, S.	11
North, C. L.	156
Nôtomi, S.	40
O'Brien, Geo. L.	12
Odén, Sven	50
Ogawa, Isuke	101
Ogawa, T.	124
O'Neill, Frank	128
Ottman, R. E.	21

[1] The abbreviation (*C. A.*) at the end of an abstract indicates that the abstract was secured from the Editor of *Chemical Abstracts* by coöperative agreement.

Author Index to Abstracts for November (*Continued*)

Author	Number of abstract
Patee, F	163
Petts, E	58
Polanyi, M	29
Purdy, Ross C	2
Rees, W. J	60
Reutlinger, E	81
Rieke, R. and Paetsch, W	103
Roost, H. J	4
Rowart, Eugene	129
Rule, John F	127
Saar, R	23
Samuelson, Alexander	135
Sauvageon, V. M	69
Schleiffer, Hedwig	46
Seidle, Chas. B	159
Seto, K	36
Sexton, F. Peake	18
Sharp, Donald E	116
Shibata, R	122
Shrader, J. E	93
Sieurin, E., Carlsson, F., and Kjellgren, B	61
Simpson, Leon G	32
Slawson, C. B	25
Smithells, Arthur	14
Spence, H	42, 44
Steger, W	82
Steinbrecht, G	104
Stuart, A. T. and Middleton, G. N	33
Sturtevant, L. H	15
Sugie, S	120
Takahashi, Sotaro	114
Taylor, M	56
Uchida, T	147
Vaillant, P	47
Wainford, R. H. and Darling, Chas. H	99
Weidlein, E. R	19
Welch, Francis C	157
Whipple, Robt. S	22
White, W. P	27
Wildman, H. G	45
Willard, E. V	105
Winqvist, Nils	66
Wittemore, Allen P	137
Wolcott, E. R	34
Wolf, K	160
Woods, L. G	112
Wyatt, J. R	72
Zopf, Eberhard	30

General and Miscellaneous

1. The influence of small amounts of electrolytes on stability of clay suspensions and their use in purification of clay. H. KOHL. *Ber. der Deut. Keram. Gesellschaft*, **3**, Pt. 2, 64–77(1922).—The stabilizing effect of Na_2CO_3 and Na_2SiO_3 on suspensions of clay, quartz, mica, pyrites, and iron oxides was investigated. All these materials in fine suspension in dil. alk. soln. are negatively charged and on electrolysis are deposited at the anode; hence it is not possible to purify a clay by the electrosmosis process, which merely acts as a filter. The impurities in clay are pptd. at lower concn. of alk. than kaolin, and can be partially removed by a correct regulation of the alk. concn. in the settling tank. It is possible to stabilize a clay free from polyvalent salts with much less alk. than is needed when such salts, as $CaSO_4$, etc., are present. The viscosity of a clay slip was found to reach a min. with 0.3% Na_2CO_3, while it had a max. stability with 0.83%. The adsorption of ions by kaolin was measured by adding it to solns. of Na_2CO_3 and Na_2SiO_3 and detg. the cond. in an ordinary Bunsen cond. cell. The cond. decreased nearly proportionate to the amt. of kaolin added. The stabilizing effect of alk. at low concn. is attributed to the mutual repulsion of the neg. charged particles. As the concn. of the alk. exceeds the max. stabilizing value, the coagulating influence of the cation begins to predominate. E. N. BUNTING

2. Benefits of technical and scientific research. ROSS C. PURDY. *Glass Worker*, **41**, No. 47, 11(1922).—Address before the Window Glass Manufacturers Ass'n. R. J. MONTGOMERY

3. New uses for clay. ANON. *London Times Trade Supp.*, **10**, 374(1922).—Describes uses of clay: (1) In the manuf. of rubber, (2) rubber latex, a new material for water-proofing paper and linoleum. China clay and rubber may be utilized as road surface material possessing a high resistance and dust-combating qualities. Describes expts. made to increase hard-wearing qualities of rubber by addition of mineral substances to obviate the tedious series of cures for each mixing, by using a base mix contg. rubber, 100 pts. (by wt.), litharge, 30 pts., sulphur, 5 pts. Stress-strain curves were obtained. China clay vies with zinc oxide as reinforcing agent, although the breaking tension is less well maintained. The toughening effect of various pig-

ments was arrived at by a consideration of conditions governing abrasive wear, as in automobile thread. The object was to increase the energy absorption of rubber to lessen stressing the rubber substance past its rupture point. Barytes continuously diminished the energy content while china clay increased it. China-clay producers are keenly interested in expts. with road-surface materials since the substance counteracts the stress on the rubber that causes rupture. O. P. R. O.

4. Canadian institute of chemistry. H. J. ROOST. *Can. Chem. & Met.*, **6**, 128.—The report of the Secretary shows the institute to have progressed favorably in its organization and to be now ready to enter upon the work for which it was created, that is "To raise the profession of Chemistry to its proper position among the other learned professions" and "To look after and promote the professional well-being and interests of Chemists" and to assist in the development of the Dominion of Canada.

O. P. R. OGILVIE

5. Technical excursion in the north and in Belgium. ANON. *Céramique*, **25**, 193–7, 241–51(1922).—The French Society of Ceram. Manufs. took an excursion through N. France and Belgium and visited a large number of ceramic plants.

H. G. SCHURECHT

6. German glass society. ANON. *Keram. Rundschau*, **30**, 325(1922).—On July 9, a meeting was held for the purpose of organizing a German Glass Society. Their address is Frankfurt a. M. Gutleutstrasse. H. G. SCHURECHT

7. Plant of the Huron Clay Products Co. ANON. *Clayworker*, **78**, 148–9(1922).—The brick and tile plant at Croswell, Mich., is described, in which the Boss system of drying and burning is employed. H. G. SCHURECHT

8. The third annual meeting of the German Ceramic Society. ANON. *Keram. Rundschau*, **30**, 309–11, 318–20, 325–7(1922).—At this meeting the following papers were given: (1) Fine stoneware, by W. Pukall; (2) Study of porcelain with low firing temps., by W. Funk; (3) The testing of ceramic bodies for artificial teeth, by H. Eisenlohr; (4) The use of geology in ceramics, by W. Braun; (5) The ceram. industry of U. S., by K. Endell; (6) The influence of typical fire clays on the behavior of refractory bodies at high temps., by W. Steger; (7) The coeff. of expans. and several other physical properties of whiteware and its dependence upon the compn. and firing temp., by H. Kohl; (8) The influence of compn. of porcelain upon its properties by R. Rieke; (9) Construction in the ceram. industry, by U. Sauer. (Abstracts of the above papers are given.) H. G. SCHURECHT

9. CO_2 in flue gas when burning oil. ANON. *Brick & Clay Record*, **61**, 259 (1922).—An error in interpreting the CO_2 content in flue gas when burning oil is likely to arise among engineers who have been familiar with coal burning. This comes from the fact that perfect combustion of coal would give a higher CO_2 reading than perfect combustion of oil. The explanation of this lies in the greater amount of H in the oil. The H requires O for its combustion and this in turn brings N which appears in the flue gas. The H does not produce CO_2 and the water vapor that it does produce does not appear in the flue gas analysis. The result is that the higher the H content in the fuel the lower the theoretical per cent CO_2 in the flue gas. H. G. SCHURECHT

10. Report of experiments on producer-gas. K. MORIMOTO. *J. Jap. Cer. Assoc.*, **341**, 149–51; **342**, 187, 192; **343**, 230–3(1921).—At window-glass works of the Asahi Glass Co., producer-gas is used in hot state except a small portion. The author, noticing that the usual method of sampling gas and its quant. analysis after it is cooled did not indicate the true nature of the gas, attempted the quant. analyses of water-vapor and tarry matter besides usual constituents. The several methods failed. After many trials, a new app. was designed which has proved to be satisfactory enough for factory use. The app. consists of 4 flasks, an elec. fan and a gas-meter. Hot

gas is forced to pass successively through the flasks by the suction of fan which discharges the gas to the gas-meter. The first flask is partly filled with water or heavy oil to which the end of tube, leading hot gas, dips and has also a tin-plate cylinder filled with broken glass or beads at the end of exit tube while the other 3 are empty; the second flask has a cylinder similar to the former; the third flask is just like the second except the cylinder, which is filled with glass-wool; the last flask has a cylinder contg. absorbent cotton and a thermometer. The temp. of gas at the outlet of the last flask is kept 1–2°C higher than that of the room; the flasks are therefore cooled with water or ice. Sample is collected through a tube inserted downward into downcomer or side walls of gas-main. Now setting the fan in motion, about 10 cu. ft. of gas is taken. Water-vapor and tar, condensing in the cooler, are collected, and their amts. are detd. The compn. of the gas at the outlet of the gas-meter is detd. in usual way. In calcg. the vol. of vapors, assumptions are made that tar consists of naphthalene and also that water and tar exist in gaseous state at ordinary temps. The expts. at a factory revealed poor nature of the hot gas, therefore many improvements on the producers and their manipulation were undertaken. The following table shows the compns. of the producer-gases before and after improvements:

TABLE I

		CO_2	O_2	C_2H_4	CO	CH_4	H_2	N_2
Before impr.	Cold gas	7.28%	0.56%	0.68%	16.30%	5.20%	13.54%	56.44%
	Hot gas	5.78	0.45	0.54	12.95	4.13	10.76	44.97
After impr.	Cold gas	6.28	0.25	0.27	20.00	8.67	12.20	52.33
	Hot gas	5.72	0.23	0.25	18.20	7.90	11.10	47.66

		H_2O	$C_{10}H_8$	B.t.u. per cu. Shaku (net)	Combustion temp.	Temp. of gas
Before impr.	Cold gas	...	..	156.20	1578°C	20°C
	Hot gas	20.20	0.22	138.20	1494°	170°
After impr.	Cold gas	...	..	192.40	1606°	20°
	Hot gas	8.70	0.24	189.60	1637°	220°

The calorific power of gas increases as its water content decreases. However the water-vapor which is introduced by the moisture and combined water of coal is unavoidable, and its amt. is about 5.10% at the said factory. S. KONDO

11. The present condition of ammonia-soda industry in Japan and its future. S. NAKAHARA. *J. Jap. Cer. Assoc.*, **352,** 624–30(1921).—Descriptions on the demand of soda-ash in Japan and statistics on soda industry in foreign countries are given. The ammonia-soda plant which was established in 1917 by the Asahi Glass Co., manufacturers of window glass, has since had better experience, and is now mfg. about 10 T. of soda-ash a day. Raw materials, fuel and labor required for mfg. one T. of soda-ash in March, 1921, were as follows: 1.9 T. salt (85%), 1.5 T. limestone (98%), 1.1 T. coal (with 22% ash), 0.2 T. coke (with 29% ash), 0.014 T. ammonia and 10 workmen (8 hrs.). Cheaper supply of salt and prevention of dumping by foreign manufacturers are needed to the further development of the industry. S. KONDO

12. The plant manager and the chemist. GEO. L. O'BRIEN. *J. Ind. Eng. Chem.*, **14,** 650–1(1922). E. J. C. (*C. A.*)

13. Can the college do anything for industry? EDWARD ELLERY. *J. Ind. Eng. Chem.*, **14,** 544(1922).—The college can reduce the period of unproductiveness of their graduates when they enter industry by training them in the acquisition, recognition, application and description of facts, and finally in handling an original problem. For this purpose it is essential that there be (1) small instructional groups, (2) superior

students sepd. from inferior students, (3) strongest teachers in charge of freshmen and seniors, and (4) a limitation of the number of students and of the number of hours the good teachers teach. W. C. EBAUGH (*C. A.*)

14. The blue flame produced by common salt on a coal fire. W. HUGES. *Nature*, **109**, 683(1922).—Arguments are advanced to show that the blue flame which is seen when NaCl is thrown on a coal fire is due to CO produced by the cooling of the hot coal by the NaCl rather than to traces of Cu in the coal. ARTHUR SMITHELLS. *Ibid.*, 745.—The work of different investigators is quoted to show on the contrary that the blue color is due to $CuCl_2$, the source of the Cu being the pyrites of the coal. W. H. ROSS (*C. A.*)

15. Crushing, storing and pulverizing. L. H. STURTEVANT. *Rock Products*, **25**, No. 3, 28–9(1922).—Almost entirely mechanical. The following topics are discussed: phosphate rock, unloading power shovels, crushing, pulverizing, air separators, dust collectors, storage, and labor requirements. E. F. PERKINS (*C. A.*)

16. Geography of electrochemistry. W. S. LANDIS. *J. Ind. Eng. Chem.*, **14**, 554–5(1922).—Hydro development possibilities of the five continents and the East Indies are discussed. The struggle for supremacy will be between the United States, Norway, India, China and Canada. W. H. BOYNTON (*C. A.*)

17. Industrial research. ANON. *Electrician*, **88**, 450(1922).—A short report on the activities of the Brit. Elec. & Allied Industries Research Assoc. Brief comments are included on micas, synthetic resins, insulating oils, turbine blades, etc. C. G. F. (*C. A.*)

18. The future of industrial research. F. PEAKE SEXTON. *Electrician*, **88**, 627(1922).—A general discussion. "The personnel of the laboratory is the most important item." C. G. F. (*C. A.*)

19. The place of scientific research in the programs of trade associations. E. R. WEIDLEIN. *Chem. Age* (N. Y.), **30**, 241–3(1922). E. H. (*C. A.*)

PATENTS

20. Process of manufacturing liquid gold. JIRO ISHIKAWA. Japan 40,632, November 14, 1921. Sulphur-balsam is added to a soln. of gold chloride and the mixt. is heated on a water-bath. Sulphur-resin-gold, thus prepd. is washed and heated to evap. water. Then, aluminium resinate, uranium resinate and bismuth resinate are added. The product is dissolved in the mixt. of lavender and rosemary oils. S. KONDO

21. Electrical insulation. R. E. OTTMAN. U. S. 1,418,730, June 6. A non-conducting fabric such as paper or cardboard is impregnated with a soln. of borax and NH_4 phosphate, dried and then coated with a mixt. of $CaCO_3$, ZnO and linseed oil. (*C. A.*)

Apparatus and Instruments

22. Some of the difficulties encountered in maintaining a pyrometer installation in a works. ROBERT S. WHIPPLE. *Trans. Ceram. Soc.* (Eng.), **21**, 1–23(1922).—The pyrometer should be placed where the fireman can see the records readily. He thus soon regards it as a friend, whereas, if it is in the manager's office he thinks of it as a policeman. The following points are useful for standardizing thermocouples: Freezing point of tin, 231.8°C; of lead, 327.4°C; of zinc, 419.4°C. (The f. p. of zinc is particularly useful; detns. made on a sample continuously for 6 yrs. in one crucible gave strictly consistent results.) Boiling point of sulphur, 444.7°C; freezing point of antimony, 630.7°C; of sodium chloride, 800°C. (The f. p. of common salt (NaCl) 800°C is an extremely useful point, as small variations in the purity of the material make practically no difference.) Freezing point of silver, 960.8°C; of copper, 1083°C.

The galvanometer must be placed where it is not abnormally heated nor subject to temp. variation. If accuracy is desired, the temp. of the end of compensating leads must be controlled. The simplest way is to use a thermos flask filled with oil, the juncture of copper leads being placed near the bottom of the flask. The temp. of the surrounding air may change 20°C during 24 hrs., yet the temp. inside the flask remains const. to within 1°C. Another way is to bury the junction at a depth of 10 to 12 ft. below the floor. Works of any size should possess a potentiometer for checking the couples and galvanometers. Radiation and optical pyrometers are graduated to give the true temp. under black-body conditions. The industrial furnace practically fulfills these conditions. A closed fire clay or quartz tube (not less than 10 cms. internal diam.) built into a fur. gives almost ideal conditions. As long as the image of the hot body formed by the concave reflector is large enough to cover the small thermocouple in the pyrometer, the instalment is independent of the distance between it and the hot body. The importance of black-body conditions is greater in the case of radiation instruments. The only way to maintain a successful pyrometer installation is to make it definitely someone's business to look after the instruments. The substitution of a new porcelain or quartz sheath for a broken one will save the thermocouples and a good deal of worry. The leads and switches between the pyrometer and indicator or recorder must be kept clean and in good order. (See *Ceram. Abs.*, **1**, 199(1922).) H. F. S.

23. Pycnometer density determinations. R. Saar. *Chem.-Ztg.*, **46**, 433–5 (1922).—A series of tables, calcd. to 6 decimal places, for correcting to standard conditions densities detd. under a given set of conditions. Illustrated by problems. W. C. Ebaugh (*C. A.*)

24. Recording calorific value of gas. The Fairweather recording calorimeter. Anon. *Gas World*, **77**, 12–13(1922).—This instrument has been provisionally prescribed by the Gas Referees for producing continuous records at the Brentford Gas Plant. This calorimeter comprizes, briefly, a water-flow calorimeter of the Boys type, adapted to record continuously the total ht. value of the gas, reduced to standard temp. and pressure. This automatic and continuous operation is effected by combining with the calorimeter proper the following automatic devices: Means for supplying to the calorimeter a definite and measured water flow; means for automatically adjusting such flow to compensate for the effect of temp. and pressure conditions of the gas; a time-controlled wet meter adapted to supply gas uniformly to the calorimeter at a const. rate; a recording thermometer adapted to indicate the temp. rise imparted to the water passing through the calorimeter. This temp. rise is a direct measure of the calorific value of the gas and is converted into B. t. u. by appropriate ruling of the record sheet. Details are given by reference to a diagram. J. L. Wiley (*C. A.*)

25. An apparatus for handling deliquescent crystals. C. B. Slawson. *Am. Mineral.*, **7**, 25–6(1922).—The crystals are handled in a galvanized-Fe box with glass windows at top and front, the arms of the operator entering through rubber sleeves at either end. E. T. Wherry (*C. A.*)

26. Two machines for rapidly weighing loads of a few milligrams. Research Staff of The General Electric Co., Ltd., London (E. M. and C. G. Eden). *J. Sci. Instruments*, Prelim. No. **1922**, 15–21.—The two machines described were designed for sorting elec.-lamp filaments to an accuracy within 5% of their wt. A cantilever spring is used in the first machine and the motion of its end is magnified by optical projection 30 times. The scale (0 to 40 mg.) is 13 cm. long. The second machine consists of a small weighing beam controlled by a hair spring. Mechanical magnification between 10 and 100 times is obtained by a fine wire tension lever connecting to a wire hanging in a catenary under its own wt. The movement of the catenary wire is magnified optically 30 to 50 times. Curves showing sensitivity of balance, and effect

of stiffness of controlling spring and catenary are given. The speed of each balance is about 400 filaments per hr. D. E. S. (*C. A.*)

27. The thermel. W. P. WHITE. *Science*, **55**, 617–8(1922).—The classical names, thermocouple and thermopile, are awkward when applied to temp.-measuring instruments, which frequently include both at once, and where the mere number of parts is usually a secondary matter. A single term for all such instruments is desirable. The term "thermoelectric thermometer" is logical, but unnecessarily long; "thermoelement" is not logical, and its use has caused considerable confusion. The term "thermel," which is merely an abbreviation of "thermoelectric thermometer," is logical, short and definite, has met with general informal approval, and is urged as a desirable general term for all thermoelec. temp.-measuring devices. "Thermocouple" and "multiple thermel" (or "thermopile") may still be used in the few cases where it is desirable to call attention to the special construction of the thermel. W. P. WHITE (*C. A.*)

28. Union gas calorimeter. AXEL DANIELSON. *Teknisk. Tidskrift*, **52**, 313–4 (1922).—A modification of Strach's calorimeter, designed by O. Dommer, Karlsruhe, was tried out in a Stockholm gas plant. It is a very serviceable instrument. It gave caloriç values which averaged 2% less than the Junker calorimeter.

A. R. ROSE (*C. A.*)

29. Röntgenographic determination of crystal arrangement. M. POLANYI. *Naturwissenschaften*, **10**, 411–6(1922).—Röntgenographic methods must be employed to det. whether a crystal lattice is changed by elongation of a single crystal. By means of a filament diagram it was found that for a Zn crystal (1) the lattice changes its orientation with respect to the longitudinal axis when elongated; (2) in the section drawn out to a flat band (cf. Schiebold, *Z. Physik*, **9**, 180(1922); Carpenter and Elam, *C. A.*, **16**, 1728; Gomperz, *C. A.*, **16**, 1387) the angle that the hexagonal axis of the crystal lattice makes with the longitudinal axis changes from 10° to 18° and (3) the cylindrical filaments resulting from further elongation of the flat bands have the same orientation of their lattices as the flat bands. It is maintained that this same kind of shift in the orientation of the lattice occurs in a Zn wire as in the individual crystal. A bibliography is appended. C. C. DAVIS (*C. A.*)

30. Total-radiation pyrometer. EBERHARD ZOPF. *Z. Ver. deut. Ing.*, **65**, 1267 (1921).—Brief description of the Siemens and Halske so-called Ardometer.

W. P. WHITE (*C. A.*)

PATENTS

31. Brick-hacking machine. WILLIAM H. ALLEN. U. S. 1,414,998, May 2, 1922. In a hacking device for bricks and the like, the combination of means for feeding a plurality of bricks in succession, a turntable, a transfer car carried thereby adjacent the delivery end of said brick feeding means, and means for moving the turntable parallel to the direction of movement of the bricks in the brick-feeding means.

C. M. S., JR.

32. Lens-grinding machine. LEON G. SIMPSON. U. S. 1,415,613, May 9, 1922. The combination of a lens carrier and a grinding tool coöperating therewith, one of the parts having a recess on the side thereof opposite the other of the parts, a guide bar and a universal joint between the recessed part and bar comprising a bearing member within the recess and rounded on the bottom for pivotal movement in the recess and a pin pivotally connecting the bearing member and guide bar within and adjacent the bottom of the recess. C. M. S., JR.

33. Apparatus for reactions at high temperatures under pressure. A. T. STUART AND G. N. MIDDLETON. U. S. 1,417,585, May 30. The app. is adapted for *cracking hydrocarbons*. It comprizes a closed reaction chamber the wall of which is of a material

having a high elec. resistance by which it may be heated by elec. current to the desired reaction temp. The reaction chamber is surrounded by reinforcing material to support its wall against internal pressure. (*C. A.*)

34. Electrical precipitation of suspended particles from gases. E. R. WOLCOTT U. S. 1,416,769, May 23. Before pptn. by the action of an a. c., gases such as cement kiln or smelter gases are humidified to facilitate the pptn. of suspended particles from them. (*C. A.*)

Chemistry, Physics and Geology

35. The chemical composition of a rock known as the kaolin from Djebel Debar (Algeria). ALBERT GRANGER AND PIERRE BRÉMOND. *Comptes Rendus*, **175**, 36–8 (1922).—The material is white and contains no mica and no quartz impurities; will not disintegrate after months of immersion in water. When crushed and well mixed with water, a sticky mass is obtained which seems to contain 2 constituents, (1) a hard inert material, (2) the material which is miscible with water. For porcelain it is ground with water in a ball mill. The chem. compn. is SiO_2 34.99, Al_2O_3 34.65, Fe_2O_3 0.22, CaO 0.55, MgO 0.04, K_2O 0.83, Na_2O 0.31, ignition loss 28.19. The Al_2O_3 content and the ignition loss are higher than for kaolins. It is much more easily attacked by acids than is kaolinite. LOUIS NAVIAS

36. Chemical composition of alkalic feldspar. K. SETO. *J. Jap. Cer. Assoc.*, **343**, 237–40; **344**, 269–71(1921).—Hitherto published analyses of feldspars do not agree well with their optical consts., probably owing to the difference in samples. To make up the deficiency, the same crystals whose optical properties had been detd. by Prof. Kozu of the Tohôku Imperial University were analyzed as accurately as possible. The samples include albite of Alp Rishuna, orthoclase of Madagascar, moonstone of Ceylon, adularia of St. Gothard, same of Riedertobel and a native perthite. The composition of the perthite which is produced at Kutsuwatori, near Ishikawa, Fukushimaken, is as follows: 65.44% silica, 19.55% alumina, 0.05% ferric oxide, 0.12% magnesia, 0.49% lime, 3.77% soda, 10.78% potash, 0.18% loss on ignition and 100.38% in total. Mineral compn. of the perthite is, therefore, $Or_{62.8}Ab_{33.7}An_{2.5}$. The mineral is used in potteries. S. KONDO

37. The action of heat on refractory clays; and their rational analyses. K. FUHA. *J. Jap. Cer. Assoc.*, **351**, 566–98(1921).—The study was carried out with the object of getting full knowledge on clays used in the manuf. of pots for optical glass. The soly. of 6 clays in boiling conc. hydrochloric acid, and analyses of the solns. and residues are described. Soly. ranged 23–75% when boiled for $1^1/_2$ hrs., and 93–96% on boiling for 24 hrs. Lime and magnesia were almost completely dissolved. The loss on heating at various temps. is described. The temps. at which the wt. of Japanese clays decreases most rapidly are 400–500°C. The soly. of 7 clays, previously heated at various temps., in boiling hydrochloric acid is discussed. The result, in short, confirms that of A. N. Sokoloff in 1912. The methods of rational analysis and its published discussions are described. Clay, heated up to 800°C may be used for rational analysis; there were wonderful differences in the amts. of residues between clays, heated at 1000° or 1100°, and those heated at 1200°. This increase is due to those of alumina and silica, their ratio in equivalents being about 1:2. S. KONDO

38. Clays of the Mount Hongo in Fukushima prefecture. K. HOJO. *J. Jap. Cer. Assoc.*, **355**, 98–105(1922).—Hongo is one of the chief porcelain producing districts in Japan, the products being known as Aizu ware. Clays of the Mt. Hongo are chief body materials of the Aizu porcelain; they are decomposed liparite. Clays of the best quality have compns. as follows:

Name of clay	Ignition loss	SiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO	P_2O_5	Na_2O	K_2O
Jari.....	4.34	78.50	13.16	0.46	0.52	1.29	0.26	...	0.97	0.81
Okubo.....	5.14	71.43	17.83	0.55	..	1.87	0.79	0.46	1.27	0.90

S. KONDO

39. The ceramic materials in Saga prefecture. K. IHARA. *J. Jap. Cer. Assoc.*, **353,** 3–15(1922).—A detailed geological survey of the districts producing raw materials of pottery is given. Izumiyama which was found about 300 years ago by S. Li and since has been used as the chief raw material of famous Arita porcelain is a decomposed liparite. The liparite is composed of fine-grained feldspar and quartz, the former being kaolinized markedly; it has sometimes minute iron pyrites and is silicified in part by fine veins of chalcedony. The presence of alum in some of the cleavages and the strong smell of sulphur in the mine indicate that the decompn. of its feldspar has been caused by the actions of sulphurous gas and hot spring. It is classified to 4 kinds; the best one has a compn. of 3.12% loss on ignition, 76.07% silica, 14.11% alumina, 0.88% ferric oxide, 1.97% lime, traces of manganous oxide and magnesia, 0.15% titanium dioxide, 2.67% potash and 1.36% soda. Some other liparites have probably been decomposed by weathering. S. KONDO

40. Report on clay resources for Soma wares. S. NÔTOMI. *Geological Survey, Bull.* **67.**—Geology of the region surrounding the village of Obori where the Soma stone-ware are manufd. is described. The clayey stratum of the region has probably formed by the deposition of weathered gneiss and granitic sandstone and is composed of granitic sand and kaolin. It contains also remarkable propn. of peat. S. KONDO

41. Feldspar deposits of the Ottawa District. N. B. DAVIS. *Can. Min. Jour.*, **43,** 521(1922).—Mr. Davis gives history of the deposits, and the work done on development of same; the character of the feldspar; its analyses; the method of its mining; and illustrations of the quarries and pits. O. P. R. O.

42. Barium in Canada. H. S. SPENCE. *Rept. Mines Branch,* Dept. of Mines, Canada, 1922.—This rept. gives history of baryte mining in Canada: occurrences and character of Canadian barytes; describes methods of mining and milling; gives analyses, production, exports and imports; includes the production of barytes in other countries; gives principal consumers in the U. S.; gives a general outline of process through which crude barytes pass in the prepn. of ground barytes for the trade. O. P. R. O.

43. Pottery clays in Canada. J. KEELE. *Mineral Resources of Canada,* Mines Branch, Dept. of Mines, Canada, 1922.—Describes the different types of pottery and the clays required by each. Glacial lake and estuarine clays widely distributed throughout Canada are used for the manuf. of common brick and drain tile; not suitable for pottery in their natural state. Stoneware clays are sparingly distributed in Canada and are accessible for present use in Nova Scotia and Saskatchewan only. No ball clays are found in Canada, except among the white clays of Saskatchewan. The only white burning kaolin found in Canada is in Quebec. The only known deposits of stoneware and fire clay occur in Ontario, but beyond the reach of transportation. Saskatchewan is the only region in Canada where valuable clays occur in abundance, suitable for various kinds of pottery. O. P. R. O.

44. Strontium in Canada. H. S. SPENCE. Mines Branch, Dept. of Mines, Canada, 1922.—Two commercial sources of strontium are celestite (Strontium sulphate), and strontianite (strontium carbonate). Celestite is by far the more common and most largely used in the production of strontium salts. Four occurrences of celestite of economic importance are known, all of them in Ontario. Celestite is white, cream-colored or bluish and occurs in tabular crystals, and in aggregates of fibrous or columnar crystals. Its hardness is 3 to 3.5, being lighter than barytes; sp. gr. is 3.9. Pure celestite contains 56.4% strontia and 43.6% sulphur trioxide. It is readily distinguished

from barytes by flame test. The chief sources of the world's supply of celestite are England and Sicily. Strontianite is more valuable since it is readily sol. in acids. Weight for wt., it contains 70.3% strontia but most strontianites have a portion of their strontia replaced by lime. Strontianite commands a higher market price than celestite and is a relatively rare mineral occurring in economic quantities very rarely. Prussia is the most important source; occurs as a gangue mineral in Germany and Scotland; found in California in the form of irregular masses of clay. The chief use of strontium is as strontium hydrate in the beet sugar industry; also used to make "red fire" signal flares; also for medicine. Strontium carbonate is used in iridescent glass and for hardening copper castings. Celestite has been employed as substitute for barytes as a filler and in the manuf. of lithopone. O. P. R. O.

45. Process for the extraction of alumina and its salts from clay. H. G. WILDMAN. *Quarry, Surv. and Contractors' Jour.*, **27**, 233(1922).—The clay, preferably china clay, is boiled in alk. soln. made of boiling soda ash with an insufficient quantity of lime to convert all the carbonate to hydrate, 30 lbs. soda to 100 lbs. clay. The liquid is drawn off after settling and sodium carbonate and sodium hydrate added, after which the soln. is again ready for use. The clay is agitated in cold water and treated with sulphur dioxide from burning pyrites or sulphur under pressure until all absorption ceases. The mixt. is filter-pressed, obtaining pptd. silica and the filtrate passed into a second digester fitted with closed steam coils and a vacuum pump. On heating, the higher sulphides of aluminium are decomposed, giving up the sulphur dioxide in soln., the gas is removed by the pump and recovered. The aluminium is pptd. and ignited to recover the sulphur dioxide. O. P. R. O.

46. The surface tension of colloidal solutions. HEDWIG SCHLEIFFER. *Kolloid Z.*, **30**, 273–8(1922).—The surface tension at different temps. was detd. for a number of colloidal solns. in H_2O. Azobenzene, myristic acid, mastic and gum arabic were found to lower the surface tension of the dispersion medium but gamboge and hydrous Al_2O_3 did not affect it. The temp. coeff. of the colloids was almost identical with that of H_2O. Investigation showed that neither the viscosity nor the vapor tension of H_2O was changed by the presence of the suspended particles, indicating that little or no soln. took place. HARRY B. WEISER (*C. A.*)

47. Variations in the conductance of solid electrolytes. P. VAILLANT. *J. phys. radium*, **3**, 87–100(1922); cf. *C. A.*, **15**, 987.—When a solid electrolyte such as CaS is placed between metal electrodes and a voltage applied, polarization takes place and finally after some hours reaches an equil. value. If the temp. is suddenly changed the cond. undergoes 2 changes, one almost instantaneous, the other slow. The first effect is an exponential function of the abs. temp. The second effect is manifested in a series of oscillations of which the final effect is an increase or decrease in cond. depending upon whether the temp. has been lowered or raised. The increase or decrease is more rapid as the temp. change is greater. C. R. PARK (*C. A.*)

48. Capillarity. I. Some general considerations and a discussion of methods for the measurement of interfacial tension. A. FERGUSON. *Trans. Faraday Soc.*, **17**, 370–83(1922).—No data are given. Twenty methods for *measuring surface tension* are mentioned. Of these methods, capillary rise, pendant drop, or bubble, and sessile drop are mathematically analyzed. The surface tension of solids may be detd. either by change of soly. with size of particle, or change of vapor pressure with change of size of the particles considered. **II. A modification of the capillary-tube method for the measurement of surface tension.** A. FERGUSON AND P. E. DOWSON. *Ibid.*, 384–91.—The modification described consists in measuring the total pressure "p_a" above a meniscus in a capillary tube immersed in the liquid whose surface tension is to be detd. $p_a = P + g\rho h + (2T/R)$. P is the atm. pressure; ρ, the density; h, the depression

of the meniscus below the surface of the liquid; T, the surface tension; and R, the radius of curvature at the vertex of the meniscus. The surface tension of benzene was found to be 29.58 dyne-cm.$^{-1}$ at 15°. Benzene is not considered a good standard liquid, for it showed a surface tension of 29.6 dyne-cm.$^{-1}$ after careful purifying and additional crystn., and the same samples after a few days showed a surface tension of 29.9 dyne-cm.$^{-1}$ F. E. BROWN (*C. A.*)

49. Rapid tests for copper in pyrite and iron minerals. A. BRALY. *Bull. soc. franç. minéral.*, **44,** 119–21(1921).—A content of Cu as low as 0.7% is revealed by the red coloration of a $NaPO_3$ bead, heated in the reducing flame with the addition of SnO; smaller amts. by the characteristic blue flame color, obtained by roasting the powdered mineral on a mica support, adding HCl, and evapg. EDW. F. HOLDEN (*C. A.*)

50. Clays as dispersed systems. SVEN ODÉN. *Trans. Faraday Soc.*, **17,** 327–48 (1922).—No given chemical component is necessary, in order to classify a soil as a clay. A soil layer is a clay, a silt or a sand soil according to whether the greatest part falls within the limits for clay, loam, or sand. These limits are detd. by size of particles. Clays are disperse formations of mineral fragments in which particles of smaller dimensions than 2 μ predominate. Odén detd. the distribution of sizes of particles by collecting the particles settling through a tall cylinder of water on to a plate suspended near the bottom of the cylinder by a fine gold wire. The upper end of the gold wire was attached to the left pan of a balance fitted with an elec. appliance which automatically added successive equal wts. to the right pan when the accumulated sediment equalled the wts. already added. A second device recorded the time at which each wt. was added. The formula for calcg. the effective radius r of the particles is, $r = \sqrt[3]{(3/4\pi)\ (vp/sn)}$ in which v is the vol. in cm^3., p the number of g. of suspension per cm^3., s the sp. gr. (always taken as 2.7) and n, the number of particles in volume v. The method for applying this equation to a soil suspension is shown. By using suspending media having different densities and viscosities practicable rates of deposition of sediments from the finest particles up to those 50 μ in radius are possible. F. E. BROWN (*C. A.*)

51. New uses for zirconium. R. E. KIRCHNER. *Chem. Ztg.*, **46,** 380(1922).—Large deposits of zircon in South America and Mexico make this substance of potential importance. It has been used as an abrasive, in making "siloxyd" glass (superior to quartz glass because not sensitive to the action of oxides of the heavy metals), etc. ZrO_2 is the best elec. insulator at high temps., *e. g.*, 2000°. It can be used for making refractories, enamels, coloring porcelain dark violet, prepg. high-grade steels, and jackets for electric furnaces. Zr can be employed as a substitute for Pt for many purposes, especially in chem. labs. Its carbide might replace the diamond for cutting tools in the glass industry. W. C. EBAUGH (*C. A.*)

52. The solubility of small particles and the stability of colloids. L. F. KNAPP. *Trans. Faraday Soc.*, **17,** 457–65(1922).—In the presence of an excess of the substance of which the disperse phase is composed, colloidal particles are uniform in size. This is due to the fact that the soly. of particles of this size is the same as the soly. of the large undispersed body. This soly. is due to the combined effect of surface tension and the elec. charge on the surface of the particle. An equation is derived for the value of r the "critical" radius of such suspended particles. $r = \sqrt[4]{q^2d/8\pi K\sigma}$ in which q is the elec. charge on a particle, d the distance between the double elec. layers (Helmholtz), K the dielec. const. of the dispersion medium and σ the interfacial tension between the suspended particle and the dispersion medium. AgBr pptd. in gelatin forms in various small-sized particles. But after 40 min. heating the grains are uniform and larger than the largest particles first formed. To explain this increase in size one must assume either that the charging of the particle is a gradual process of adsorbing ions, or that the complete pptn. of the AgBr is delayed by the gelatin. In this case

there is no plane surface so the final size must be the size of minimum soly. The article is largely mathematical. F. E. BROWN (*C. A.*)

53. Notes on the preparation of some fluorescent and phosphorescent compounds. W. S. ANDREWS. *Am. Mineral.*, **7**, 19–23(1922).—Detailed directions are given for prepg. in a condition such as to exhibit max. luminescence the compds. Zn_2SiO_4, $Cd_3(PO_4)_2$, $(Cd, Zn)_3(PO_4)_2$, and ZnS, all contg. Mn as a necessary impurity; pure $Cd(OH)(PO_4)$, $CdSO_4$ and $ZnSO_4$; and a fluoride contg. some NH_4F. E. T. WHERRY (*C. A.*)

Refractories and Furnaces

54. Burning ceramic products in electrically heated furnaces. ALBERT GRANGER. *Compt. rend.*, **175**, 98–100(1922).—Pieces were burned in a platinum ribbon resistance furnace and in a granular carbon resistance fur., of lab. types. The latter was built around a horizontal clay-bonded corundum tube, 66 cm. long and 10 cm. in diam. The impure corundum was obtained from the alumino-thermal process of making metallic chromium, and was purified by treating with sulfuric and hydrochloric acids. In the platinum fur. due to the continued oxidizing conditions light-colored burned pieces were easily obtained. In the carbon resistance furnace a porcelain body turned out greyish, a condition that is met with in commercial kilns when the atm. is too reducing. The grey color would then be explained as being due to the occlusion by the glaze of finely divided carbon, which has not been burned and is being carried by the flame. In the present case there was no flame to carry the carbon. The corundum tube, however, was porous enough to allow gases to pass through. Carbon monoxide passed through the cylinder, and burned at the mouth of the tube when opened to the air. By allowing a good draft to pass through the tube the trouble from darkening of the pieces was obviated. It is assumed that the carbon which colored the porcelain in the carbon resistance furnace came from the deposition of carbon from the decompn. of the gas: $2CO = CO_2 + C$. LOUIS NAVIAS

55. Refractory cements and protective coatings. C. E. BALES. *Clayworker*, **78**, 140(1922).—B. discusses the effect of substances most commonly added to fire clay and their effect. Common salt, sand, cement, water glass, lime, and asbestos decrease the refractoriness of fire clays while fire clay grog increases the refractoriness. Carborundum dust mixed to a pasty consistency with water, makes a very good protective coating but it does not add a great deal to the life of the refractory. H. G. SCHURECHT

56. Eleven year oil burning experience. M. TAYLOR. *Brick & Clay Record*, **61**, 246–7(1922).—The Vincent Clay Products Co., drain tile manufs. of Ft. Dodge, Ia., operate an 18-chamber Goldner patent kiln of the Youngren type. Each chamber is fired from the top through a series of 11 fire holes. These are spaced $3^1/_2$ ft. apart along the side of the chamber, and the flame impinges on brick fire boxes which are built into the flash wall. Only 2 firemen are necessary; there are no unsightly piles of coal or ashes and the ware is free from scum. Before making a change from coal to oil it is well to consider the following items: (1) A careful comparison of the actual operating costs of fuel oil *versus* coal, as estimated for the particular locality in question, (2) the advantages in favor of oil that can not be estd. in money, such as, clean yards, no coal or ashes, increased quality, better satisfied and more efficient burners, (3) a decision should be made as to whether the high pressure or low pressure air system would give best results and (4) the cost of installation. Formulas for fuel comparison:

$$\text{For coal } C = \frac{A}{2000\,B}$$

$$\text{For fuel oil} = \frac{D}{E\,F\,G}$$

A = Cost of a ton of coal delivered at the point of use
B = B.t.u. per lb. of coal
C = Av. cost of each B.t.u. in the coal
D = Cost of a bbl. of fuel oil delivered at the point of use
E = B.t.u. per lb. of oil
F = No. of lbs. of oil to the gal.
G = No. gals. to the bbl.
H = Av. cost of each B.t.u. of oil

In comparing the costs for any two fuels the costs of operation and the investment must be taken into account in addition to the difference in fuel value. The av. efficiency of coal is 60% and that of fuel oil is 70% and this must be taken into consideration.

H. G. SCHURECHT

57. An oil gas compensating tunnel kiln. ANON. *Brit. Clayworker* (1922); *Céramique*, **25**, 198–9(1922).—A tunnel kiln with two tunnels side by side is described. The cars run in opposite directions in each of the tunnels and in this manner the waste heat is better utilized.

H. G. SCHURECHT

58. Knacks in setting up-draft kilns. E. PETTS. *Brick & Clay Record*, **61**, 211–42 (1922).—Detailed directions are given on setting and firing up-draft kilns.

H. G. SCHURECHT

59. Resistance tests on refractory products under load at different temperatures. V. BODIN. *Trans. Ceram. Soc.* (Eng.), **21**, 56–65(1921–22).—See *Jour. Amer. Ceram. Soc.*, **4**, 69(1921).

H. F. S.

60. Notes on American practice in refractories. W. J. REES. F. I. C. *Trans. Ceram. Soc.* (Eng.), **21**, 69–88.—An excellent general description, laying emphasis on efficient plant lay-out and the use of labor-saving machinery.

H. F. S.

61. Load tests on refractory bodies at high temperatures. E. SIEURIN, F. CARLSSON AND B. KJELLGREN. *Ber. der. Deut. Keram. Gesellschaft*, **3**, Pt. 2, 53–64(1922).—The softening temp. under press. of a fire-clay body mixed with varying amts. of SiO_2, Al_2O_3, Fe_2O_3, CaO and MgO, were detd. in a carbon resistance furnace. The clay had a soft. temp. of 1280°C and a m. p. of 1750° C. Small additions of Fe_2O_3, CaO and MgO lowered the soft. pt. rapidly. When the SiO_2 content was increased, a min. soft. pt. was reached between 60–70% SiO_2, although the lowest m. p. was at 90% SiO_2. With Al_2O_3 the max. soft. pt. was at 80% Al_2O_3. Seven graphs are given to show the effect of the added materials upon both the soft. pt. and m. p. The soft. pt. of good SiO_2 brick is 1650°C and of carborundum brick, 1800°C, the soft. pt. being taken when a linear shrinkage of 0.3% results under a press. of 2 kg./cm^2.

E. N. BUNTING

62. On tunnel kilns. S. MOMOKI. *J. Jap. Cer. Assoc.*, **347**, 385–91(1921).—Although small tunnel kilns have been used for over-glaze coloring more than 10 years in Japan, Mr. K. Okura, president of the Toyo-Toki Co., was the pioneer in adopting large tunnel kiln for hard firing. In August, 1920, a Dressler tunnel kiln was completed at their factory. The result of seven-months' expt. was quite satisfactory. As to the saving in fuel, 315 lbs. of second-class lump coal of Kyushu were required for heating one car load of sanitary ware, measuring 70 cu. ft., to cone 6, while 6-m. round kilns of English style consumed 875 lbs. of the same coal in firing the equal vol. of saggers to the same temp. Conclusions are (1) that the building cost of a tunnel kiln is about 3 times as much as round kilns of same capacity, (2) that the kiln house for round kilns costs 2 times as much, for faience, and 2½ times as much for porcelain as tunnel kiln, (3) round kilns require about double space, compared with tunnel kiln, for faience, whereas the ratio is just reversed in porcelain works and (4) also that the excess of fixed capital in the erection of tunnel kiln is cancelled by its general advantages, and accordingly it reduces the cost of production by the saving in fuel and the utilization of waste heat.

S. KONDO

63. Investigation of refractory materials: the after-contraction test. D. A. JONES. *Quarry, Surv. and Contractors' Jour.*, 27–143(1922).—A preliminary rept. of work carried out under the auspices of the Joint Refractory Materials Committee of the Institution of Gas Engineers and the Society of British Gas Industries. Tests were made on the whole brick instead of smaller pieces. Two measurements were taken along the length, two along the width of the brick face, and the mean of each pair of readings taken. The temp. was raised over a period of 4 hrs., maintained at cone 14 for fire brick and cone 12 for silica brick; for a further period of 2 hrs. they are heated in a combustion fur. oxidizing atm. The chief source of error due to dislocation of surface of brick is that the calipers measure not only the change in length but also this indefinite surface change.

O. P. R. O.

64. Report of the Refractory Materials Research Committee. A. E. BROADBERRY. *Gas World*, **76**, 553–9; *Gas J.*, **158**, 840–52(1922); cf. *C. A.* **15**, 3377.—Reference is made to the need for improvement of the after-contraction or expansion test as found in the Gas Institution's standard specification for refractory materials of Nov. 1912. In regard to the retort specification (cf. *C. A.* **14**, 2411), it had originally been intended to make the retorts only from fire clay with admixture of grog, but it was now necessary to add Si and siliceous materials, aluminous materials, carborundum, etc., as well as mixts. of them. A new definition of what constitutes *signs of fusion* was suggested as being that condition "when the angular edges of the test piece begin to lose their angularity when heated under conditions stated." The contraction test had also proved difficult to carry out, the size specified being too large (4.5 in. sq.). It was now proposed to use smaller test pieces (3.5 x 1.5 to 2 x 1.5 to 2) and to place them vertically instead of horizontally. An endeavor is being made to overcome the difficulty experienced in taking the necessary measurements by allowing a tolerance of 1% for exptl. errors, but the actual allowance for contraction or expansion has been reduced from 1.25% to 1%. **Standardization of the after-contraction test.** D. A. JONES. *Gas World*, **76**, 554; *Gas. J.*, **158**, 840–4; cf. *C. A.* **16**, 808. **Thermal conductivity of refractory materials at high temperatures.** A. T. GREEN. *Gas World*, **76**, 554–8; **77**, No. 1980 (Coking Sec.), 13–18; *Gas J.*, **158**, 844–51.—The report is unsuitable for abstracting; the results being expressed mostly in tabular form. Previous work on the subject is reviewed. As regards the relationship between porosity and thermal cond., results of the expts. suggest that at high temps. (1400–1500°) some of the pore spaces lose their insulating properties, and even at 1100° have the capacity for transmitting heat at rates comparable with the solid matter. Diffusivity is indicated as being the measure of the rate of rise of temp. produced in a material. It varies with temp. in a manner similar to that of thermal cond., and in carbonizing its measurement would form a satisfactory criterion of the thermal efficiency of the material, while in furnace work where insulation is desirable, the measurement of thermal cond. would be more satisfactory.

J. L. WILEY (*C. A.*)

65. Electric steel plant at the Southern Pacific shops. L. J. BARTON. *Chem. Met. Eng.*, **26**, 838–40(1922).—A steel-making plant comprizing a 6-ton Heroult elec. furnace with equipment for making ingots and castings is described. The installation of the elec. furnace was made after a careful comparison of cupolas and converters, open-hearth and elec. furnaces for working up the available scrap. The elec. furnace was selected as the most suitable on the basis of the superior quality of elec. steel, a slight advantage in cost of the finished steel, and the adaptability of the elec. furnace to a wide variety of products. The basic process was chosen since the available scrap was high in S and P on account of large quantities of wrought Fe mixed with it. Operation of the furnace follows the standard 2-slag process. Data from 2 years' continuous operation show an av. power consumption of 565 kw. hr. per ton of charge; electrode consumption

of 30 lb. of carbon or 12 of graphite per ton of product. The bottom of dead-burned magnesite is still in good condition after 2 years of const. operation. This furnace has been used in the production of rivet steel, tie plate steel, steel castings, and synthetic cast Fe. LOUIS JORDAN (*C. A.*)

PATENTS

66. Rotating kiln for burning cement. NILS WINQVIST. Sweden 1,415,970, May 16, 1922. A rotary kiln having a preparatory heating zone, and flat projections extending from the wall of the zone and leaving a free central passage in the kiln, the projections being spaced longitudinally and circumferentially of the kiln and having large surfaces parallel to the direction of rotation and presenting thin edges and open spaces to the material in the direction of rotation, thereby to prevent lifting of the material by the projections during rotation. C. M. S., JR.

67. Rotary kiln. ALEXANDER B. CARSTENS. Mexico 1,415,990, May 16, 1922. A rotary kiln having openings intermediate the ends thereof, means for normally closing the openings during substantially a complete revolution of the kiln to prevent the escape of gases therefrom, and means coöperating with the first-named means to cause a momentary opening of the same, thereby permitting material to pass through the openings into the kiln. C. M. S., JR.

68. Kiln. RICHARD K. MEADE. U. S. 1,416,657, May 16, 1922. In a kiln for burning lime or the like the combination of an upright ore chamber, a coal burning fur. at the bottom of the chamber connected to the ore chamber so the latter acts as a stack, a stoking grate in the furnace composed of rocking sections and a drop bar means for operating the stoking grate outside the fur., hopper feeding means for supplying the fuel to the grate, the bottom of the kiln and the fur. being closed normally and during stoking to prevent the admission of excess air to the kiln. C. M. S., JR.

69. Electric furnaces. V. M. SAUVAGEON. Can. 219,805, June 20, 1922. A resistance furnace heating by radiation through the crown has the space above the crown filled with a resistance material. The crown and walls of the furnace are composed of a good conductor of heat which becomes an electric conductor at high temp. See *Ceram. Abs.*, **1**, 236(1922). (*C. A.*)

70. Electric furnace adapted for refining metals. H. DE NOLLY. U. S. 1,417,303, May 23. (*C. A.*)

71. Electrode furnaces. W. DYRSSEN. Can. 219,975, June 20, 1922. The electrodes are arranged in the furnace in a common counterbalanced system, one counterbalancing another. (*C. A.*)

72. Induction furnace having uni-directional circulation. J. R. WYATT. Can. 219,098. Beneath the furnace chamber and connected therewith is a resistor channel, of restricted cross-section in one part, for molten metal, in combination with an a. c. transformer having one leg threaded through the channel. The leg is nearer the metal at the more constricted part of the channel than other parts thereof. (*C. A.*)

73. Refractory material. WM. A. FRANCE. Can. 219,609, June 13, 1922. A small amt. of molten $MgCl_2$ is mixed with burned magnesite, the mixt. is moistened, then molded and pressed into the desired shape and allowed to dry without burning. (*C. A.*)

74. Electric furnace regulator system. C. A. BODDIE. Can. 219,625, June 13, 1922. The system comprizes an adjustable electrode operated by a motor, switches for controlling the direction of rotation of the motor, a main control electromagnet operated in accordance with the current passing through the furnace for selectively operating the switches and means controlled by the switches for directly varying the energization of the main control magnet in accordance with the switch operated. (*C. A.*)

75. Electric furnace regulator systems. C. A. BODDIE. Can. 219,624, June 13,

1922. The system has an electromagnet controlled in accordance with the current of the arc and a second magnet controlled in accordance with the voltage across the arc, both magnets coöperating to govern the same contact members which govern reversing switches for an electrode motor. The reversing switches govern elements for varying the energization of the electromagnets in order to prevent hunting action. Means are also provided for establishing a dynamic braking circuit for the electrode motor. (*C. A.*)

76. Abrasive and refractory articles. A. H. ANDERSON. Can. 219,646, June 13, 1922. A compn. for forming ceramic articles contains refractory or abrasive cryst. grains, a plastic clay, water and an oily lubricating agent. Cf. *Jour. Amer. Ceram. Soc.*, **4**, 241(1921).

77. Tilting electric furnace. W. DYRSSEN. U. S. 1,416,699, May 23. (*C. A.*)

78. Refractory composition. C. A. FRENCH. U. S. 1,418,372, June 6. Zr oxide and steatite are used together to form a compn. adapted for crucibles, furnace linings or spark plug insulators. (*C. A.*)

79. Refractory material. R. W. HULL. U. S. 1,418,648, June 6. A refractory material adapted for lining furnaces is formed of the residue remaining from the concn. of Cr ore contg. a mixt. of SiO_2, serpentine and olivine, united by a binder such as pitch, tar or Al_2O_3. (*C. A.*)

BOOK

80. The electric furnace in the iron foundry. LYMAN C. JUDSON AND HARRY P. MARTIN. *Trans. Am. Electrochem. Soc.*, **41**, advance copy (1922).—A bibliography, briefly abstracting each reference. LOUIS JORDAN (*C. A.*)

Stoneware, White Ware and Porcelain

81. The firing of porcelain in tunnel- and round-kilns. E. REUTLINGER. *Ber. der Deut. Keram. Gesellschaft*, **3**, Pt. 3, 121–46(1922).—From exhaustive expts. the best firing curves have been developed, showing the course of the temp. and the analysis of the flue gases. The present practice of many burners, to keep all parts of the kiln at the same temp., or to produce a reducing atmosphere, causes a waste of fuel either through too large an excess of air or of unburned gases. By using the recommended firing schedules a good burn with respect to fuel consumption, time of burn, and yield is obtained. The necessary measuring instruments must be installed and the burner taught to use them. The use of control methods does not necessitate a radical change in the usual practice, but allows the burner to know at all times the condition of the kiln. Although the expense of control instruments is fairly large it is justified by the saving in fuel, better yields, and independence from experienced burners. E. N. BUNTING

82. The transparency of porcelain. W. STEGER. *Ber. der Deut. Keram. Gesellschaft*, **3**, Pt. 2, 50–3(1922).—The influence of sand, quartz, and geyserite upon the transparency of porcelain was detd. A body contg. 30% Norwegian quartz, 40% kaolin, 30% feldspar, burned to cone 15, is 3 times as transparent as a similar body contg. Hohenbockaer sand or Taunus geyserite. When the kaolin content is 50%, feldspar 25%, Nor. quartz 25%, the transparency is twice that of a similar body contg. the sand, and 4 times that contg. the geyserite. E. N. BUNTING

83. Chromatics and its application to painting porcelain. W. FUNK. *Ber. der Deut. Keram. Gesellschaft*, **3**, Pt. 2, 77–86(1922).—This is an address delivered before a meeting of the Ger. Ceram. Soc. in which the author defends the esthetics of color, developed by Ostwald, as applied to the decoration of porcelain. See *Jour. Amer. Ceram. Soc.*, **4**, 247(1921). Normal colors and harmony of colors. W. OSTWALD. *Ibid.*, **4**, 780(1922). Fundamentals of theory of color measurement. W. OSTWALD. E. N. BUNTING

84. The latest literature on the "lead question." P. BARTEL. *Ber. der Deut. Keram. Gesellschaft,* **3,** Pt. 2, 86–108(1922).—The literature later than 1912 concerning lead compds. is reviewed under the headings (1) Laws and regulations. (2) Transactions and discussions in meetings, congresses, and parliaments. (3) Hygienics (publications of physicians, etc.). (4) Technical (research and practical expts. with lead glazes). E. N. BUNTING

85. Zirconium fluoride glazes. F. KRAZE. *Ber. der Deut. Keram. Gesellschaft,* **3,** Pt. 3, 157–61(1922).—The following formulae give good turbid white glazes maturing at cone 05a, applicable to either porous pot ware or iron ware:

(1) 0.735 Na_2O		3.007 SiO_2	(2) 0.728 Na_2O				
0.214 K_2O	0.234 Al_2O_3		0.234 K_2O	0.301 Al_2O_3	3.161 SiO_2		
0.051 BaO		0.184 ZrF_4	0.029 BaO	0.035 Al_2F_6	0.061 ZrF_4		

The frit must be kept molten until all SiF_4 escapes. Before grinding the frit, 0.020 kaolin is added to (1) and 0.058 to (2). Raw materials used are quartz, soda, potash feldspar, barium peroxide, sodium fluosilicate, cryolite, and zirconium silicate. E. N. BUNTING

86. On the ratio of Al_2O_3 and SiO_2 to RO in porcelain glazes, fired at high temperatures. Y. KITAMURA. *J. Ind. Chem. Tokio,* **2,** 89–102(1921).—The research was carried out with a view to study the effect of the variation in the ratio of alumina and silica to bases on the physical properties of hard porcelain glazes and therefrom to find the best ratios for various temps. The range of compn. of glaze was RO, 0.2–2.2 Al_2O_3, 4–26 SiO_2, where RO is 0.5 KNaO, 0.5 CaO in one series and 0.1 KNaO, 0.9 CaO in the other. Glaze was applied on 3 different biscuit bodies and burned to cones 11, 14 and 17. The results are shown with 6 diagrams, plotting alumina as ordinate and silica as abscissa. Conclusions: (1) The area within which glazes have marketable lustre and also the area wherein glazes are undermatured but have at least a slight lustre are elliptic. (2) The lustre-area expands as firing temp. rises; at the same time, the centre moves in the opposite direction to the origin of axes. (3) Glaze at the centre of lustre-area is probably the best one. Thus, the compns. of the best glazes have been calcd.

TABLE I

CHEMICAL FORMULAS OF THE BEST GLAZES

Firing temp. (Seger cone)	RO = 0.5 KNaO, 0.5 CaO	RO = 0.1 KNaO, 0.9 CaO
11	RO, $0.9Al_2O_3$, $8SiO_2$	RO, $0.7Al_2O_3$, $6.0SiO_2$
14	RO, $1.05Al_2O_3$, $10SiO_2$	RO, $0.95Al_2O_3$, $9.5SiO_2$
17	RO, $1.1Al_2O_3$, $15SiO_2$	RO, $1.1Al_2O_3$, $14.5SiO_2$

(4) Extending the result, glazes for intermediate temps. and other different RO can be calcd. Two examples are given:

TABLE II

CALCULATED FORMULAS OF GOOD GLAZES, HAVING 0.1KNaO, 0.9CaO as RO

Firing temp. (Seger cone)	RO	Alumina	Silica	Firing temp. (Seger cone)	RO	Alumina	Silica
11	1	0.70	6.0	15	1	1.01	11.0
12	1	0.80	7.0	16	1	1.06	12.7
13	1	0.88	8.2	17	1	1.10	14.5
14	1	0.95	9.5	..	.	..	..

TABLE III

CALCULATED FORMULAS OF GOOD GLAZES, HAVING 0.3KNaO, 0.7CaO as RO

Firing temp.	RO	Alumina	Silica	Firing temp.	RO	Alumina	Silica
11	1	0.80	7.0	15	1	1.05	11.2
12	1	0.87	7.7	16	1	1.08	12.8
13	1	0.94	8.6	17	1	1.10	14.7
14	1	1.00	9.8	..	.	..	..

(5) Along the major axis of lustre-area which has been named "Lustre Axis," silica varies proportionally with alumina. The ratio is 0.1 Al_2O_3: 1.0 SiO_2 except when glazes, with 0.1KNaO, 0.9CaO as RO, are burned at cone 11; in this case, the ratio is 0.1 Al_2O_3: 0.8 SiO_2. (6) The max. amts. of alumina and silica in the lustre-area are as follows:

Firing temp. (Seger cone)	RO = 0.5 KNaO, 0.5 CaO	RO = 0.1KNaO, 0.9 CaO
11	$1.3Al_2O_3$, $12SiO_2$	$1.1Al_2O_3$, $9SiO_2$
14	$1.5Al_2O_3$, $15SiO_2$	$1.5Al_2O_3$, $15SiO_2$
17	$1.9Al_2O_3$, $23SiO_2$	$1.9Al_2O_3$, $23SiO_2$

(7) Some of the glazes in lustre-area have crazed. Member at the center and those around it are safe while those near the boundary and, moreover, poor in alumina have tendency to craze. S. KONDO

87. How to prevent smoke from pottery kilns. S. MOMOKI. *J. Jap. Cer. Assoc.*, **349,** 474–80(1921).—A social question is now arising on the subject in some districts of the country. The author has long been investigating various methods of preventing smoke from kilns firing faience and porcelain. They are discussed in detail: (1) Elec. pptn. is too expensive; (2) use of pulverized coal is probably injurious, as the best domestic coals contain 10–20% of ash; (3) firing with heavy oil is too expensive; (4) expt. with Kraft's mechanical stoker has shown good result for faience, fired at cone 7; but the need of even-grained coal and the excessive burning-out of metallic parts make its use for hard-fire porcelain doubtful; (5) methods of consuming flue gases by the introduction of hot secondary air, such as P. A. F. Schultz's patent, are promising; but their application to old kilns is expensive or inconvenient; (6) gas firing with pressure-gas producer is probably better than the methods described above; (7) use of tunnel kilns is most promising; but gas firing and the use of tunnel kiln need ample space of which some factories are devoid. S. KONDO

88. Canadian feldspar quarries. EDITORIAL. *Can. Min. Jour.*, **43,** 515(1922).—This article makes special mention of the host of small feldspar quarries throughout Ontario and Quebec. O. P. R. O.

89. A china clay mine. ANON. *Can. Min. Jour.*, **43,** 523(1922).—Description of mine and mill of the Canadian China Clay Co. at Huberdeau, Quebec. The history of the company and the development work done is given; the geology, origin, character and size of deposits given; plant described; analyses of clay given and flow sheet of mill. O. P. R. O.

90. New uses for china clay. ANON. *London Times Trade Supp.*, **10,** 214(1922).—Colloidal clay is produced by chem. processes from china clay. It is a highly refined and purified material which commands lbs. per T. more than ordinary china clay. The production of this clay is arousing interest in china clay circles. O. P. R. O.

91. Electrical porcelain research. M. H. HUNT. *Elec. J.*, **19,** 94–6(1922).—The combined efforts of the elec. engineer, physicist, chemist and ceramist have resulted in the production of elec. porcelain along more scientific lines. A modern lab. is illus. Properties of the ingredients that enter the body, those of the body as a whole, and those of the fired porcelain are considered in evaluating elec. porcelain, in addition to the be-

havior on burning. For the present at least research will be largely cond. on present materials and present general procedures. Standardization of test pieces, app. and tests seems impossible. W. H. BOYNTON (*C. A.*)

92. Mechanical tests for raw materials used in the manufacture of porcelain. W. DEMUTH. *Elektrotechn. Z.*, **43**, 605–10(1922); 15 illus.—A detailed description of the new Hermsdorf lab. and equipment. C. G. F. (*C. A.*)

93. Electrical tests for porosity of electrical porcelain. J. E. SHRADER. *Elec. J.*, **19**, 118–9(1922).—The most important property of elec. porcelain is its dielec. strength, which is in turn indicated by power-factor and resistance. A simple test to det. how moisture absorption affects the latter properties is described. Four insulators of known history were dried overnight at 200° and after cooling filled with Hg and floated in a shallow tray of Hg. The power-factor was measured by a sensitive electrostatic watt-meter and the resistance with a sensitive high-resistance galvanometer. The Hg was then replaced by water and the measurements were immediately repeated. The insulators were allowed to stand in water for 7 days, measurements being made at intervals. Curves for the power-factor of each insulator are shown. Resistance measurements showed that the poorest one had a different moisture absorption. Dielec. tests on these insulators showed that this one punctured at low voltage. Further soaking tests in water and in dye showed that the recorded results are characteristic. The power-factor detn. is very good and a sure indication of moisture absorption which is an indication of the porosity of the porcelain. Resistance measurements only distinguish a good insulator from a poor one. The const. slope of the poor insulator may indicate failure under high potential when sufficient moisture has been absorbed and may be the cause of the deterioration of apparently good insulators on storage or long service. The work shows the direct relation between the power-factor of insulators and their dielec. strength and that barring mechanical troubles or faulty design it depends upon moisture absorption as a result of porosity. W. H. BOYNTON (*C. A.*)

94. Standardization of filter presses. ANON. *Chem. Trade J.*, **70**, 718–9; *Chem. Age* (London) **6**, 788–9(1922).—Report of a joint committee of the Assoc. Brit. Chem. Mfrs. and the Brit. Chem. Plant Mfrs. Assoc. E. H. (*C. A.*)

95. Process of manufacturing granite-porcelain. TOMOTARO KAWAMOTO AND GOSUKE KATO. Japan 40,582, November 9, 1921. A porcelain is made of a body which is prepd. by mixing coarse grains of granite to the other ingredients, *i. e.*, feldspar, quartz, amalgatolite, Kibushi clay, limestone and water. The fired products look like granite. S. KONDO

96. Process of manufacturing talc pottery. KOSUKE HIRANO. Japan 40,963, November 30, 1921. Magnesite, calcined at 600–1200°C, is added to the body materials of talc pottery. In most cases, the talc is previously heated at a high temp. S. KONDO

97. Artificial marble. ARAJIRO HISADA. Japan 38,873, June 11, 1921. Plastic porcelain bodies of different colors are cut to irregular pieces and thrown together in a mold, then the mold is filled with similar body of white or other color and pressed. The shaped body is fired after drying. The surface of the fired product is, sometimes, polished. S. KONDO

98. Process of decorating pottery. KOSABURO KANO. Japan 38,872, June 11, 1921. A design or lettering is printed on paper with a paste composed of glaze 8, orchid-root 1, syrup, sugar or rice-jelly 1 and proper amt. of warm water, then it is transferred on biscuited ware; a hard-fire color is painted on the design or lettering and its neighborhood. The print repels the color and remains uncolored. Now glaze is applied on the whole surface and the ware is fired at high temps. S. KONDO

PATENTS

99. Apparatus for the manufacture of pottery ware. RICHARD H. WAINFORD AND CHARLES H. DARLING. U. S. 1,408,663, March 7, 1922. In apparatus of the class described, the combination of a machine for forming clay and a drying stone having a series of movable ware-boards, means intermediate the machine and the drying stove whereby the movement of the ware-boards is synchronized with the operation of the machine, and means for automatically stopping the operation of the machine at a predetermined stage of its operation. C. M. S., JR.

100. Process of forming clay image. EIZABURO MURAKOSHI. Japan 39,732, August 30, 1921. Clay images, imitating ancient "Haniwa," are formed with plastic clays, using a cloth bag filled with sand as core, which is taken out afterwards by discharging the sand. The images are then fired in a kiln. S. KONDO

101. Process of fixing a tack to an artificial tooth. ISUKE OGAWA. Japan 39,267, July 14, 1921. A vertical slit and a horizontal hole are made so as to meet at a point within a porcelain tooth. After firing at a high temp., a small plate of silver or brass is inserted into the bottom of the slit and a tack of platinoid, gold or nickel into the hole. Then the tooth is heated to the m. p. of the plate to weld it with the end of the tack. S. KONDO

102. Firing earthenware. C. J. KIRK. U. S. 1,418,446, June 6. The articles to be fired are passed through heating zones in which the temps. are independently controlled. (*C. A.*)

Art and Design

103. The constitution of some ceramic coloring materials. R. RIEKE AND W. PAETSCH. *Ber. der Deut. Ceram. Gesellschaft*, **3**, Pt. 3, 147–56(1922).—On heating mixts. of oxides together contg. either Cr_2O_3, Al_2O_3, or Fe_2O_3 as one component, compds. are obtained with the general formula $RO.R_2O_3$. Of these compds., many of which show characteristic colors, the chromites are chem. most stable, and are well suited for underglaze colors. The formation temp. differs for the various compds., being quite low for those contg. ZnO. In contrast to the chromites, the aluminates and ferrites are easily decomposed or dissolved by glazes, depending somewhat on the compn. of the glaze. The chromites are also decomposed by glazes high in PbO and low in clay, part of the Cr_2O_3 going over to chromite. E. N. BUNTING

See Abs. 84.

Heavy Clay Products

104. The laying of wall tile. G. STEINBRECHT. *Keram. Rundschau*, **30**, 287 (1922).—Tiles are molded with oblique grooves on the rear which makes them adhere to the wall better. The ends also are molded at 45°. H. G. SCHURECHT

105. Concrete tile failures in alkali soil. E. V. WILLARD. *Brick & Clay Record*, **61**, 248(1922).—Concrete tile are destroyed by the water in 14 counties of the 22 southwest counties of Minn. The total salt content of soil moisture exceeds 0.01% in each of these cases. H. G. SCHURECHT

106. On plasticity of clays. J. W. MELLOR. *Trans. Ceram. Soc.* (Eng.), **21**, 91–103(1922).—Plasticity enables a clay to change its shape without cracking when subjected to a deforming stress. The elasticity of the wet clay is negligibly small. Clay possesses high binding power when dried and fired, so that the form impressed on the clay is retained more or less persistently. Many definitions of plasticity confuse these two distinct properties and assume that the binding power is implied in the term plasticity. A great many methods for measuring plasticity are based on the binding power of the dried clay. This is not always true. No known property of the dried

clay can be used as an infallible index of plasticity and measurements of plasticity dependent on some property of the dried clay can therefore be dismissed. Plasticity is a mechanical property. Until shown that it is a definite function of some quality such as dye-absorption, viscosity of slip, etc., it can not be assumed without reservations that measurements of these qualities measure plasticity. A modified colloidal hypothesis gives the best working explanation of several properties of clay. The stuff obtained by evapg. the "clear" liquid from ball clay, is a deep, hard, horny mass resembling glue. It adheres to the tongue tenaciously and, like glue, swells enormously when wet with water and shrinks and cracks when dried. Cornish china clay gave about 0.005% and Devonshire ball clays gave about 0.05%. It is doubtful if this product represents all the colloidal matter in these clays. No difference could be detected in the plasticity of the clay from which *l'argile colloide* had been removed. M. is inclined to think that the colloid plays an important part in the drying of clay. H. F. S.

107. The dehydration of dried clays. J. W. MELLOR, N. SINCLAIR AND P. S. DEVEREUX. *Trans. Cer. Soc.* (Eng.), **21,** 104–6.—Finely powdered samples of clay were dried over 25 per cent sulphuric acid, and placed in desiccators containing sulphuric acid of different concentrations at a constant temperature of 25°. The samples were weighed every week until constant. The time occupied was approximately three months. If years were available, possibly more water would be lost by the clay.

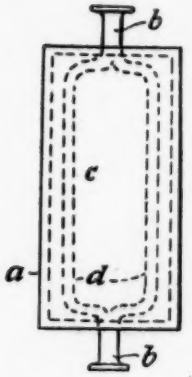
PERCENTAGE LOSS IN WEIGHT ON EXPOSURE OF DIFFERENT CLAYS IN DRIED ATMOSPHERES

Per cent H_2SO_4	Ball clay	China clay	Glenboig clay	Halloysite	Kaolinite	China clay	Halloysite
30	0.08	0.16	0.09	0.10	0.06	0.01	0.06
40	0.24	0.12	0.11	0.41	0.08	0.06	0.44
50	1.63	0.20	0.30	0.93	0.12	0.13	1.67
60	2.31	0.24	0.48	1.84	0.18	0.16	1.96
70	2.44	0.46	0.67	1.92	0.24	0.23	3.26
80	3.29	0.52	1.12	2.37	0.38	0.36	3.62
90	3.54	0.55	1.48	2.58	0.46	0.50	4.05

E. Lowenstein's observations are thus confirmed. Water, combined in clay, is reversible, restored in a moist atmosphere, showing that no drastic change has occurred in the structure of the clay molecule. This change is different from that when water is expelled at higher temps. Resorption of water is so slow that it requires a long time to restore the original plasticity; hence the working qualities, plasticity, shrinkage, etc., of certain troublesome clays can be modified and regulated by dessication. The dried clay like unweathered fire clays requires exposure to moist atmosphere for a long time before the original plastic condition is resumed. The custom of seasoning glass pots for a few months in a warm, dry place may not be so redundant an opern. as might be supposed. Storing of clays in a warm, dry spot is injurious to plasticity. H. F. S.

108. Apparatus for drying bricks, stones, and ores. R. E. COWELL, of Urmston, Eaglescliffe, S. O., Co. Durham; and A. WILKINSON, of Clyde House, Eaglescliffe, S. O., Co. Durham. *Quarry, Surv. Contractors' Jour.* (London), **266,** 27 (1922).—Relates particularly to apparatus for this purpose, in which the material to be dried is spread on trays, heated by passing a heating agent such as steam or hot air into internal passages provided, into the body of the trays. According to the invention, a portable drying floor for drying bricks, stones, and ores, consists in a hollow tray made up of one single piece, casting, sheet, plate, or the like, of iron, concrete, ferro-concrete, or any

other suitable material, adapted to be heated by passing live or exhaust steam, waste hot gases, or any other suitable hot fluid, through the internal passage of the tray, so as to heat it by direct contact with hot fluids or through pipes, perforated or unperforated, led through the space inside the body of the tray, each tray constituting a distinct and separate drying unit. Several such trays may be connected by suitable coupling members to constitute a larger drying floor. A suitable non-conducting material or lagging may be applied externally to the tray or some portions thereof if required. The accompanying drawing shows a hollow tray provided with internal pipes forming two branched circuits. O. P. R. O.



PATENTS

109. Process of manufacturing light brick. KINJI KATADA. Japan 41,372, January 11, 1922. Bricks are formed with a body which is prepd. by mixing and kneading coarse grains of coal-cinder, contg. 25–35% of combustible carbonaceous substances, saw-dust and fire clay. They are afterwards fired in a kiln. S. KONDO

110. Method of making drain tile. P. FUNK. U. S. 1,408,877, March 7, 1922. The method of making drain tile, which consists in puncturing the tile body with a plurality of parallel rows of diagonal perforations, which are laterally parallel to each other, by means of a series of puncturing needles mounted on a common shaft, which is driven reciprocally in a diagonal direction outwardly, in such a manner as to thrust the needles periodically in a slanting direction through the body of the tile while in a plastic condition, and passing from the tile press. C. M. S., JR.

111. Off-bearing mechanism for tile cutters. ALFRED G. HAGUE. U. S. 1,411,492, April 4, 1922. In a device of this kind, spaced pneumatic grippers having means for supporting and moving them from a receiving position to a delivery position, and vice versa, and means for actuating the grippers when in a receiving position to grasp a plastic block, or brick, and to deliver the same when in a delivery position. C. M. S., JR.

112. Brick pallet. LEONARD G. WOODS. U. S. 1,416,432, May 16, 1922. A pallet for supporting bricks before and during the burning thereof, consisting of a sheet metal plate adapted to receive and support the green bricks, the plate being thinly covered with a closely adherent enamel, whereby to prevent sticking of the brick to the plate and reaction of the metal with the constituents of the brick. C. M. S., JR.

113. Hollow building tile. JOHN W. AGER. U. S. 1,414,246, April 25, 1922. A hollow building tile substantially rectangular, having in a rear corner portion thereof transverse and lengthwise intersecting partitions defining with the adjacent ends of the rear and side walls of the tile a substantially rectangular cell, there being weakened fracture lines in the two outer walls of the cell remote from the corner of the tile and so disposed and arranged that by breaking off the rear corner of the tile a jamb block is formed. C. M. S., JR.

114. Machine for manufacturing bricks. SÔTARÔ TAKAHASHI. Jap. 39,444, Aug. 3, 1921. (*C. A.*)

Glass

115. On the nature of the coloring properties of selenium red. A. A. GRANGER. *Trans. Ceram. Soc.* (Eng.), **21**, 89–90(1922).—Cadmium red is a red pigment. Introduced in a suitable flux gives a brilliant and beautiful enamel. Glassmakers produce the same color known as selenium red. Chem. constitution of both cadmium and

selenium red is unknown. Recipes for prepg. selenium red consist essentially of heating materials containing sulphur, selenium and cadmium. Sulphur may be introduced as sulphur, sodium sulphide, sodium hyposulphite or sodium sulphite. The selenium as selenium, sodium selenide or selenite or selenate and the cadmium as oxide, carbonate or sulphide. Success of prepn. does not depend on ratio between ingredients; but chiefly on method of heating and temp. Insufficient heating does not give red coloration; excessive heating produces brown or black. The best method is to heat gently on a wide surface; mixt. slowly stirred and examnd. from time to time when cooling. When hot, the pigment is more brown than when cold. At about 700°C the coloration is subject to alterations. A rapid heating will cause the sulphur to ignite, and after combustion has ceased a beautiful vermilion surface coloration is observed. If the mixt. is brown, some sulphur must be added, the whole being stirred. H. F. S.

116. American made 40-inch telescope disc. DONALD E. SHARP. *Glass Worker*, **41,** No. 45, 9(1922).—The method of making telescope discs is given in some detail. A melt of borosilicate glass was cast in an iron mold lined with fire brick and talc. The disc was annealed in a gas-heated fur., being held 14 days at 464°C. The cooling rate started with 0.2°C per hr. and increased to 6°C per hr. R. J. MONTGOMERY

117. Proper control of pot furnace conditions. HENRY W. HESS. *Glass Worker*, **41,** No. 32, 11(1922).—Discussion of the causes of variation in furnace results due to temperature draft, etc. R. J. MONTGOMERY

118. Glass for laboratory and scientific purposes. ANON. *Schnurpfeil's Review for Glass Works*, **6,** No. 64, 1247(1922).—Alumina is generally used as Al_2O_3 or as the hydrate. Three batches are given: (1) Sand 100, hydrate of alumina 5, soda ash 35, lime 20. (2) Sand 100, hydrate of alumina 6, zinc oxide 1, borax 2, soda ash 35, lime 18. One of fluorspar or sulphate may be added. (3) Sand 100, soda ash 34, hydrate of alumina 6.5, borax 6, lime 18. Alumina may be increased to 8 and borax to 10 and 1 or 2 of magnesia added. Often 1 lb. of saltpetre and .5 lb. arsenic is added to batch to improve melting. R. J. MONTGOMERY

119. Study on the life of pots, used in round pot-furnaces. K. ISHIKAWA. *J. Jap. Cer. Assoc.*, **350,** 519–34(1921).—The study includes elaborate investigations of 810 closed pots with capacity of 600 lbs. of glass and 308 "Japan pots" with capacity of 500 lbs.; it took 4 yrs. Furnaces with direct firing and those with half-gas firing were used; in either case, the flame, after ascending to the combustion chamber and playing around 3 to 6 pots, so arranged as to form a ring, was made to pass through the openings under the mouths of pots. The life averaged 12.0 meltings for covered pots and 9.5 for "Japan pots." 75% of damages in the closed pot were caused by cracking and remaining 25% owed to corrosion. 45.2% of cracks in the closed pots took place on the right and left sides. Different periods in which cracks appeared, the manner of growth of cracks, and the relation between parts of pots and the size of cracks are described. Damages due to corrosion took place chiefly at or near bottom and at the level of metal. Various expts. were done to find the cause of faults in glass of a factory where wares with stone or cord amtd. to 19.09% at that time. Of 19.09%, 3.8% were ascribable to the unskilfulness of workers, 8.4% to the age of pots, 2.2% to corroded rings, 1.76% to corroded stoppers and 0.7% to too coarse sand; thus, only 2.23% were due to unknown causes. Pots with moderate weight had the longest life. Generally speaking, the slower they are dried, the better they wear. The life is also increased by storing the plastic body longer. It depends on season of making and also on the size of grains of raw materials. The position of pots in furnace has remarkable effect. The temp. and duration of heating pots in pot arch are discussed. S. KONDO

120. On the utilization of selenium. S. SUGIE. *J. Jap. Cer. Assoc.* **341,** 152–5; **342,** 193–5; **343,** 226–30(1921).—The chamber-mud of Jap. factories mfg. sulphuric

acid contains 2–6% of selenium. Flue-dust, anode-slime, slag and other by-products of factories treating sulphur or sulphide ores are also rich in the element, as Jap. ores contain more selenium than those of other countries. I. *The recovery of selenium from waste products.* Of many well-known processes of extracting selenium from chamber-mud, anode-slime, flue-dust etc., the following two are recommended: (*a*) Selenium is pptd. by means of concd. hydrochloric acid from soln. of sodium thioselenate which has been obtained by heating the material with soln. of sodium sulphite; and (*b*) selenium in the material is oxidized by heating with concd. nitric acid; then sulphuric acid is added to drive off the excess of nitric acid; selenium is pptd. from the soln. with sulphurous acid gas, sodium sulphite and hydrochloric acid, or hydrogen sulphide. II. *Red pigment of selenium for enamel.* Four kinds of fire-red, imported from Germany before the war, had shown following compns.:

	No. 1	No. 2	No. 3	No. 4
Cadmium	28.2%	24.3%	17.3%	39.1%
Alumina	36.4	53.8	49.4	45.5
Sulphur and selenium	35.4	11.9	33.3	15.4

Starting from the result, many expts. were done, and a new method of mfg. pigments which are as satisfactory as German fire-red has been invented. The method is as follows: mixt. of cadmium sulphide and selenium is heated in a porcelain crucible gradually up to about 500–700°C and the temp. is kept till the content becomes dark brown and the fuming of violet selenium is almost over, stirring the content at times; it is then cooled, still stirring the content; batch-compns. were:

	D	E	G	F	H	A	B	C
Cadmium sulphide	82%	85%	85.5%	86%	86.5%	87%	89%	90%
Selenium	18	15	14.5	14	13.5	13	11	10

The color of the pigments changes continuously from blackish red of D to yellowish red of C. Black shade is also added by heating to higher temps. or heating up rapidly and continuing it longer. For enameling, a coating of transparent frit with 3–5% of the pigment is applied and fired on white coating. Of several frits used for the purpose, one composed of 33 sand, 30 borax, 15 fluorspar, 6 cryolite, 14 sodium carbonate and 2 nitre gave the best results. III. *Use of selenium as pink colorant and decolorizer of glass.* A historical survey on the subject is given. Concluding from many expts. the author says: (1) selenium does not color soda-lime glasses pink, but tends to give them a yellowish brown; (2) selenium, regardless of its sources, colors potash-lime glasses pink; (3) the amt. of selenium required for decoloration is about 1.5% of the amts. of ferric oxide in batches; (4) $CaSeO_3$, $BaSeO_3$ and $PbSeO_3$ are the most effective sources of selenium; (5) the action of selenium is hindered by the presence of oxidizing substances, *e. g.*, red lead; (6) the required amt. of arsenious oxide is about 3 times that of selenium. In either case, it is impossible to get a dark red glass by selenium, as it is volatile at high temps. In general, selenites of alkalies or ammonium are very hygroscopic, therefore they are inconvenient in use. S. KONDO

121. Opal glass and alabaster glass, and their applications. K. FUHA AND Y. YOSHIOKA. *J. Jap. Cer. Assoc.*, **345**, 302–17(1921).—A detailed historical survey and its discussions on the manuf. and theory of opal glass and alabaster glass are given. I. *Experiments.*—The wt. of each batch was 3 kg. for preliminary work, then it was increased to 10 kg., and at last 100–200 kg. batch was taken to manuf. various vessels or lighting goods for trial. Pot was heated by gas or heavy oil, and the temp. in fur. was completely under control. (1) Opal glass. (*a*) Silica or alumina as opacifier. Soda-lime glass, contg. more than 75% of silica, is sometimes devitrified in cooling or annealing. Aluminous hard glass, also, devitrifies in heating repeatedly. (*b*) Fluorine

compds. as opacifier. In this case, glasses composed of 65–68% silica, 9–10% lead oxide, 8–10% alumina, 2–3% lime and 12–14% alkalies were used. The rôle of alumina is to reduce the corrosive action of fluorine compds. on the pot. Introducing varying amts. of fluorine to the glass, it has been found that when feldspar or amalgatolite is used as the source of alumina about 2.5 parts of fluorine per 100 parts of glass is required for the production of opal glass, irrespectively of the kind of fluorine compds. which include fluorspar, sodium fluoride, cryolite, fluorspar and sodium fluoride whereas about 4% of fluorine is required when prepd. alumina is used. (*c*) Bone-ash as opacifier. A deep opal glass was obtained by melting a batch composed of 1200 sand, 800 litharge, 400 potash, 120 nitre, 75 borax, 20 arsenious oxide and 200 bone-ash, but it was translucent in molten state. If we cool the glass to about 800°C and heat it gradually to 1000–1100° and keep at these temperatures, a translucent glass like alabaster will be obtained. Replacing potash with same amt. of soda-ash, no effect was observed. When the amt. of bone-ash was reduced to 150 parts, a translucent glass was obtained; a batch with 100 parts of it gave a transparent one. (2) Alabaster glass. (*a*) With fluorine compds. and auxiliary agents. Since it has been ascertained in the expts. of (1) (*b*), that translucent glasses are obtained by introducing about 2% of fluorine to the said glasses when feldspar or amalgatolite is used, or by introducing about 3.5% of fluorine when alumina is used, these batches have been used as bases. Expts. with these batches to which 0.5–3.0% of various auxiliary agents were added have shown that the introduction of 1.5% or more of strontium or barium sulphate or 3.0% of calcium sulphate gives an alabaster glass. The efforts to use chlorides were useless, but mixts. of sulphate and chloride gave good results. The research resulted in the introduction of "Johga Glass" on market. (*b*) With asbestos. Asbestos batch, such as 1000 sand, 380 potash, 125 litharge, 100 asbestos and 40 nitre, gives a good alabaster glass when it is heated at a constant temp. for a certain time after it begins to melt. Melting at too high temps. makes it transparent. II. *Causes of translucency and opacity.*—(1) Opal glass is produced (*a*) by setting free colloidal silica or alumina from glasses contg. an excess of silica or alumina, (*b*) by similar cause from glasses containing flourine compds., (*c*) or by dispersing calcium phosphate colloidally in a glass. (2) Alabaster glass is produced (*a*) by the suspension of minute particles or colloid of silica or alumina, together with gaseous substances, (*b*) by the suspension of minute substances or crystals of substances other than silica or alumina, *e. g.*, magnesium silicate, together with gaseous substances, (*c*) or by dispersing substances coarsely. Microphotographs are given. Microsections of Johga glasses show innumerable gas-bubbles, ranging from 10 microns to visible size. Physical properties are described, for instance:

TABLE I

	Reflection	Transmission	Absorption	Sp. Gr.
An ordinary opal glass.....	70.0%	21.0%	9.0%	..
Johga glass No. 1.....	36.7	45.0	18.3	2.06
Johga glass No. 2.....	42.5	49.4	8.1	2.66
Johga glass No. 3.....	45.5	47.8	6.7	2.52

S. KONDO

122. A note on optical glass. R. SHIBATA. *J. Jap. Cer. Assoc.*, **349**, 481–5(1921).—Descriptions on several specimens of optical glasses which have been manufd. at the naval arsenal, Tokio, their materials, and chief raw materials of pots are given. Process of making pots is explained. S. KONDO

123. Color of glass imparted by iron. K. FUHA. *J. Jap. Cer. Assoc.*, **354**, 39–57 (1922).—Over 1500 different batches were melted to ascertain the effect of variation in the compn. of glass and the influence of oxidizing or reducing agents on the color

of glass imparted by iron. Pure chem. and ground rock-crystals were used. Three formulas were used as bases: (1) R'_2O, $R''O$, $3SiO_2$, (2) R'_2O, $R''O$, $0.5B_2O_3$, $3SiO_2$, and (3) $1.3R'_2O$, $0.7R''O$, $6\ SiO_2$, where R'_2O represents K_2O or Na_2O and $R''O$ represents CaO, MgO, ZnO, BaO or PbO. Glasses belonging to (1) or (2) were melted at 1300–1350°C while those of (3) were melted at 1400–1550°C. The color imparted by ferric oxide is described. Generally speaking, it colors soda glass blue or bluish green and potash glass yellowish green or green. The increase in the colorant adds yellow shade to soda glasses and blue shade to potash glasses. However, there are exceptions where no difference is observable between soda and potash glasses. The difference in $R''O$ affects the color, *e. g.*, ferric oxide imparts dark reddish brown to Na_2O, BaO, $3SiO_2$, light blue to Na_2O, CaO, $3SiO_2$, dull blue to Na_2O, ZnO, $3SiO_2$, and yellowish tint to Na_2O, PbO, $3SiO_2$. Boric acid does not affect the color, although sometimes it darkens or brightens the color. Besides, detailed descriptions are given on (1) the color imparted by ferrous oxide, ferric chloride, ferrous sulphate, ferrous carbonate or ferrous oxalate, (2) the effect of sodium carbonate or potassium carbonate on the coloration of ferric or ferrous oxide and (3) the effect of potassium-sodium tartrate or arsenious acid on the color, imparted by ferric or ferrous oxide. S. KONDO

124. Study of chemical glass ware. T. OGAWA. *J. Jap. Cer. Assoc.*, **355,** 91–7; **358,** 252–65(1922).—The results of chem. analyses and tests on the resistance to chem., impact and the sudden change in temp. of foreign and domestic chem. glass wares as well as those made by the author are given. In general, home products are inferior to foreign ones, owing to their improper compns. Furnaces producing high temps. and pots standing them are indispensable for mfg. chem. glasses of the best quality, since the constituents of glass which increase its resistance to chem. make it more refractory. Batches contg. proper propns. of zinc oxide, alumina, magnesia, boric acid and silica suit fur. with half-gas firing. The use of sands contg. alumina, feldspar, or dolomite is economical. S. KONDO

125. On the surface devitrification of sheet glass. Y. AMENOMIYA, K. KOJIMA AND H. OTA. *J. Jap. Cer. Assoc.*, **356,** 137–51(1922).—The paper relates to the surface devitrification of finished sheet glasses by ht. treatments. An elec. fur. was used. The microphotographs of several sheet glasses of two factories which have been heated to various temps. indicate that the temp. at which crystals begin to appear is about 700°C. The crystals produced at this temp. are spherulitic while they are changed to radiating needles, by heating at 750°. At 900°, the crystn. proceeds into interior of glass and it becomes a white sheet. At certain higher temps., the crystals melt and disappear; these temps. were 985–1130°C for 8 kinds of sheet glass. The reln. between devitrification and time of heating at various temps. is described. The time required for the devitrification which occurs in cooling a molten glass is far longer than that required for the devitrification in heating up. S. KONDO

126. Atmospheric pressure and refractive indices, with a corresponding table of indices of optical glass. J. W. GIFFORD. *Proc. Roy. Soc.* (London), **100A,** 621–6 (1922).—In work where an accuracy better than about a unit in the sixth significant figure is required it is necessary to allow for the effect of the variation of refractive index of air with variation in the barometric pressure. A table is given of the refractive indices to 7 figures for 13 different wave lengths from 7682 K to 4046 Hg for 3 crown and 4 flint glasses. E. D. WILLIAMSON (*C. A.*)

PATENTS

127. Method and means for forming and transferring gobs of molten glass. JOHN F. RULE. U. S. 1,413,788, April 25, 1922. The combination with a receptacle for molten glass having an outlet opening, of a mold below the opening open at its upper end and formed with an elongated tapered mold cavity smaller at the lower end than the

upper end, gob-transferring app. between the flow opening and mold comprising a carrier, transfer cups at the opposite sides of the carrier, the cups having gob-forming cavities shaped to conform substantially to the form of the mold cavity, means to intermittently rotate the carrier and swing the transfer cups alternately from receiving position to discharging position, and means to sever the glass and support the oncoming stream during the rotation of the cup carrier. C. M. S., JR.

128. Glass-flow-off controller. FRANK O'NEILL. U. S. 1,413,183, April 18, 1922. The combination with a container for a pool of molten glass, the container having an outlet for the glass below the surface of the pool, of controlling means for the outlet comprising a support, a refractory plunger projecting downward into the pool and having an intermediate ht.-weakened portion, the plunger embodying an upper portion sustained by the support independently of the portions therebelow, the upper portion having a central passage therethrough to a lower portion, a threaded seat, a reinforcing stem for the refractory having threaded engagement with the seat, a ht. expansion take-up spring about the stem, the spring being sustained by the support for yieldably maintaining the plunger refractory portions assembled therewith, the upper held refractory portion relieving the ht. weakened intermediate portion from crushing strain, and the stem carried lower portion relieving the heat weakened intermediate portion from tension strain, thereby distributing the load of the plunger, and means for shifting the support to vary the submergence of the plunger in the pool and normally maintaining the support in plunger sustaining position. C. M. S., JR.

129. Apparatus for the manufacture of glass in continuous sheets. EUGENE ROWART. Belgium 1,413,238, April 18, 1922. In an app. for the manuf. of glass in continuous sheets, in combination, a melting fur. for the production of molten glass, a chamber communicating with the melting fur., burners at the ends of the chamber, whereby a high temp. is produced all around the chamber, a working chamber arranged between the burners and within the chamber, and a taking app. dipped in the molten glass contained in the chambers, the taking app. being located with its upper part in the working chamber and communicating directly at its lower end with the chamber containing the molten glass, the working and the upper part of the taking app. being vertically movable and separable from the lower part of the taking app., whereby the hot gas from the burners may act on the whole surface of the molten glass contained in the chamber and also within the taking app. C. M. S., JR.

130. Method and apparatus for making glass. HUBERT A. MYERS. U. S. 1,413-766, April 25, 1922. Apparatus for making glass, comprising means to provide a reservoir supply of molten glass, means to form an opening or space for shaping the glass, through which the discharge of glass flows in molten condition from the reservoir, and instrumentalities to maintain the sides of the opening or space at a sufficiently high temp. to retain the necessary fluidity of the glass, and so that the sides of the opening will remain glazed with the highly liquid molten glass which adheres thereto from the passing flow, together with means to keep the glazed sides moving with the flow of glass. C. M. S., JR.

131. Stirring molten glass in continuous tank furnaces. WILBER F. BROWN. U. S. 1,414,008, April 25, 1922. The combination with a continuous tank fur., whereby the molten glass flows continuously from the melting end to the delivery end of the tank, of an internally cooled rod extending transversely into the tank above the flowing glass, a porcelain stirring finger projecting downwardly from the rod into the flowing glass, and means for automatically and continuously reciprocating the rod, whereby the finger will break up the continuous flow lines in the glass and increase its homogeneity. (Cf. *Ceram. Abs.*, **1**, 79(1922).) C. M. S., JR.

132. Means for filling glass melting tanks. SETH B. HENSHAW. U. S. 1,409,716,

March 14, 1922. In an app. for filling glass melting tanks, a hopper adapted to be mounted adjacent the filling opening of the tank, means for moving the hopper to discharging position within the opening, a closure for the opening, and interconnecting means between the closure and hopper, so that one of them is moved into the opening when the other is moved away. C. M. S., Jr.

133. Ring mold for glass presses and the like. Peter Kucera. U. S. 1,412,358, April 11, 1922. As an article of manuf. a ring mold for pressed glassware and the like, the ring mold comprising a body portion of relatively soft metal and having the base of the matrix groove and an inner edge of hardened compacted metal integral with the soft body portion. C. M. S., Jr.

134. Processes and apparatus for feeding glass. William J. Miller. U. S. 1,413,757, April 25, 1922. In a glass feeder, for use in connection with a container for molten glass provided with a discharge port, the combination of reciprocating mechanical means for discharging glass at intervals through the discharge port, and for attenuating the neck of the protruding glass to facilitate severance, means for severing the neck to form gathers, and a pushback to be inserted into the outer end of the port for forcing the severed neck back into the port to temporarily interrupt the flow of glass. C. M. S., Jr.

135. Conveyor for heated glassware. Alexander Samuelson. U. S. 1,414,212, April 25, 1922. A conveyor for supporting and transporting heated glassware without cracking the same, which has a roughened surface to provide air cushioning and air insulation between the surface and the glassware to retain the heat in the latter. C. M. S., Jr.

136. Method of treating and working glass. Enoch T. Ferngren. U. S. 1,415,824, May 9, 1922. The method of forming mold charges which consists in flowing a stream of glass freely through a surrounding heat delivering flame and a heated shearing medium towards a series of molds successively elevating towards the stream and shearing medium, and successively severing mold charges at the shearing medium without obstructing the downward movement of the remaining portion of the stream. C. M. S., Jr.

137. Apparatus for drawing glass. Allen P. Wittemore. U. S. 1,415,133, May 9, 1922. An app. for drawing glass cylinders, a cooling ring arranged to surround the cylinder adjacent to the drawing point, and a sectional shield detachably secured adjacent to the inner face of the ring for locally retarding its cooling effect upon the article being drawn. C. M. S., Jr.

138. Glass-cutting square. Henry E. Johnson. U. S. 1,415,650, May 9, 1922. A glass support and cutting guide comprising a pair of right-angularly connected arms, oblique braces between the arms, the arms and braces being adapted to support a sheet glass to be cut, one of the arms having a vertical longitudinal stop rib for one edge of the glass, both of the arms having graduations, the inner end of the rib terminating adjacent the inner edge face of the other arm, a cutter guiding arm pivotally connected to the outer end of the other arm, and a detent by the inner end of the rib for gripping engagement with the free end of the pivoted arm, to releasably hold the arm against the end of the rib and the glass on the angularly connected arms and braces. C. M. S., Jr.

139. Glass composition. Harry T. Bellamy and Burton T. Sweely. U. S. 1,415,980, May 16, 1922. A binder for higher resistance compns., comprising a non-electrolytic glass composed of silicates and borates of calcium and barium. C. M. S., Jr.

140. Glass-handling apparatus. Earl G. Chase. U. S. 1,414,547, May 2, 1922. A glass horse comprising a supporting base, series of uprights mounted at opposite sides

of the base, saddles comprising flexible members suspended between corresponding upright of the two series, the saddles being normally slack, and means whereby the slack of the saddles may be independently adjusted. C. M. S., JR.

141. Apparatus for feeding glass to molds. ENOCH T. FERNGREN. U. S. 1,414,561, May 2, 1922. In an app. for sepg. molten glass into mold charges, the combination of a container for the glass provided with a submerged discharge outlet, a hollow member having its lower end submerged in the glass opposite the outlet and spaced therefrom, and rigid means for creating a flow of the glass in the member toward and from the outlet. C. M. S., JR.

142. Mechanism for transferring glassware. RICHARD LA FRANCE. U. S. 1,413,741, April 25, 1922. The combination with an endless conveyor adapted to receive and convey articles seriatim, of a stop in the path of the articles to arrest them while on the conveyor, means to shift the articles laterally off the conveyor, a gripper, and means to operate the gripper to engage the articles, move the gripper bodily forward and then release it from the article. C. M. S., JR.

143. Milky semitransparent glass. KITSUZÔ FUWA and THE TOKYO DENKI KABUSHIKI KAISHA (the Tokyo Electric Co.). Jap. 39,448, Aug. 3, 1921. Glass is made by adding 1.5–3.0% cryolite, 0.5–3.0% $BaSO_4$ and below 1% NaCl to a common glass. The best total compn. is sand 100.0, steatite 35.5, litharge, 7.5, ZnO 3.0, $NaNO_3$, 6.1, Na_2CO_3 34.6, boric acid 4.5, arsenic oxide 0.5, $BaSO_4$ 1.5, cryolite 3.8, NaCl 1.9 and antimony oxide 0.4. Microscopical bubbles produced in the material make it milky and semi-transparent. It is suitable for illuminating materials, such as shades for elec. lamps. (*C. A.*)

144. Opal glass. A. L. D. D'ADRIAN. U. S. 1,419,032, June 6. An ordinary glass compn. is combined with fluostannite of Mg, Ba or Pb or other metals or silicofluorides to produce opal glass. (*C. A.*)

Enamels

145. Effect of variation in the composition of ground-coat enamel on its adherence to iron. S. MORI. *J. Jap. Cer. Assoc.*, **343**, 233–6; **344**, 272–7(1921).—Adherence of ground-coat to iron was measured by impact test, using soft steel sheets, gauge No. 28 and 1″ x 2.5″ large, as test pieces. An enamel which had proved to be very good in practice was taken as the basis of expts. Its formula is 0.455 Na_2O, 0.245 K_2O, 0.232 CaO, 0.016 CoO, 0.955 MnO, 0.198 Al_2O_3, 1.490 SiO_2, 0.455 B_2O_3, 0.200 F_2. Now the content of silica, boric acid, alumina, soda, potash or lime was varied within ranges as follows: 1.266–1.754 SiO_2; 0.455–3.200 B_2O_3; 0.198–0.227 Al_2O_3; 0.426–0.561 Na_2O; 0.214–0.306 K_2O and 0.136–0.544 CaO. Conclusions are: (1) Any increase in silica or boric acid reduces the resistance to chipping; (2) the resistance of enamel to chipping increases with the addition of alumina; (3) adherence of ground-coat is strengthened by the increase of soda, potash or lime up to a certain degree beyond which the effect is reversed. S. KONDO

146. Study of vehicles used in enamelling slip. S. MORI. *J. Jap. Cer. Assoc.*, **352**, 630–40(1921).—Explanations and discussions on the reason why enamellers use vehicles or stiffening materials, the rôle of clay in enamelling slips, theories of deflocculation of the slip, and the action of vehicles on the slip are given. The effect of various vehicles on the viscosity of an enamelling slip is shown with diagrams. A ground coat enamel with formula as 0.455 Na_2O, 0.245 K_2O, 0.232 CaO, 0.016 CoO, 0.055 MnO, 0.198 Al_2O_3, 1.49 SiO_2, 0.49 B_2O_3, 0.20 F_2, ground with 5% of washed Gairome (plastic kaolin) and 35% of water, was used for the expts. The amts. of vehicles required for one litre of slip in making its viscosity most suitable for working were as follows:

sodium chloride 4.68 g., barium chloride 0.732 g., aluminium chloride 0.3 g., sodium carbonate 8.4 g., ammonium carbonate 0.9 g., borax 1.08 g. or brine 4 cc. The effect of vehicles diminishes with the lapse of time. Concluding from the results, the author recommends (1) the use of least water, (2) the removement of water on storing slips, (3) when the use of vehicle is needed, borax, ammonium carbonate or soda-ash for ground coat, barium chloride or soda-ash for cover coat, and aluminium chloride or calcined magnesia for sol. enamels as semi-fused ground coat of cast-iron ware, and (4) the use of stiffened slip within a few hours. S. KONDO

147. Study of the opacity agents for enamels. T. UCHIDA. *J. Jap. Cer. Assoc.*, **357,** 189–201(1922).—Although antimony which is generally used in Japan for making white enamels is inexpensive and effective, so far as opacity is concerned, it is by far inferior to stannic oxide as to the appearance of enamel and moreover enamels with antimony can not be exported to some countries where their use is forbidden, and consequently the study of its substitutes is needed. The results of numerous expts. in which various substances were ground with 10 times its weight of frit, made from 26 kg. borax, 59 kg. feldspar, 2 kg. nitre and 13 kg. cryolite, applied on sheet iron and fired after drying are as follows: (1) Among opacifiers on market and those substances which were considered of high promise, only two specimens of stannic oxide proved to be excellent, Terrar, zirconia, cerium carbonate, and a specimen of stannic oxide were good and antimony oxide, rutile and Izushi clay were pretty good; (2) of various metal oxides, obtained by calcining oxalates, those of tin, zirconium, antimony and cerium were good and the oxides of lead, zinc and arsenic were pretty good; (3) among several compounds of tin, stannic oxide obtained by calcining the hydroxide at 1050°C was excellent and stannic hydroxide was good; (4) antimonic anhydride and antimony tetroxide are better than the trioxide; (5) of various antimonates and stannates, only calcium antimonate proved an excellent opacifier, and zinc stannate was pretty good; (6) the process of mfg. a compd. affects its quality as opacifier, *e. g.*, the stannic oxides which have been manufd. by igniting meta-stannic acid, $SnO(OH)_2$, obtained by oxidizing metallic tin with nitric acid, at 670–1060°C have proved pretty good opacifiers while good ones have been obtained by heating it at 1100–1230° and at last excellent ones at 1280–1435°; (7) the oxides, silicates and phosphates of aluminium and magnesium deteriorate the lustre of enamels. S. KONDO

148. Marine blue pigment for enamelling. T. FUKUDO.. *J. Jap. Cer. Assoc.*, **348,** 432–8(1921).—Marine blue color of enameled wares is usually produced in Japan by adding copper oxide to raw batches. Since various difficulties have been experienced by enamelers in such a method, its improvement is needful. A German pigment which is added at the mill in the manuf. of marine blue wares was analyzed with the result: 32.44% alumina, 4.64% silica, 1.28% magnesia and 0.60% moisture and loss on ignition; and a similar pigment made by heating a batch of 33 cobalt oxide, 24 chromic oxide, 35 alumina, 2 stannic oxide, 1 magnesia and 5 silica to cone 13 was almost as bright as the imported one. The shade of the pigment can be easily controlled. The effects of the introduction of various substances to the raw batch of pigment upon clarity of the color are described; in short, the addition of stannic oxide, antimony oxide or bone-ash makes the color clear, while zinc oxide, magnesia, lime and silica tend to make the color dark or gloomy. The most economical method is in the utilization of impure alumina which is obtained as residue in the process of extracting alum from calcined alunite; the alumina used in the expts. had 65.33% alumina, 28.50% silica, 2.46% sulphuric anhydride, 0.67% ferric oxide, 1.25% lime and 1.80% potash. A pigment, made by heating a mixt. of 55 impure alumina, 26.1 cobalt oxide and 18.9 chromic oxide to cone 13 or 15, was as excellent as that imported from Germany. In enameling, 2% of pigment is added at the mill. S. KONDO

PATENT

149. Enamel. WILLIAM A. BRIGGS. U. S. 1,409,919, March 21, 1922. A compn. enamel including 25 to 55 parts by wt. of copal gum, 5 to 35 parts by wt. of rosin, 10 to 40 parts by wt. of filling material, and 10 to 35 parts by wt. of oil. C. M. S., JR.

Cement, Lime and Plaster

150. Study of gypsum. K. KISHIMOTO. *J. Jap. Cer. Assoc.*, **357**, 201–16(1922).—The results of expts. in which 1 g. of a pure gypsum was heated in an elec. fur. at various temps. for different times, indicate that the mineral loses its water when it is heated at 90°C or higher, but the rate is very slow at 90°. Sol. anhydrite is strongly hygroscopic and changes readily to the hemihydrate in the atm. The hemihydrate takes moisture from the atmosphere; this phenomenon is merely due to physical adsorption. S. KONDO

151. Accelerated tests of Portland cement. S. KANO. *J. Ind. Chem.* (Tokio), **7**, 657–99(1921).—Hitherto proposed methods of the accelerated testing of Portland cement are described and discussed. Two Portland cements with following compns. were used throughout the study:

Cement	Insol. residue	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Loss on ignition	Total
A.....	0.20	24.42	3.80	3.25	63.52	1.03	0.97	2.10	99.29
B.....	0.17	24.67	4.61	3.20	63.79	0.72	1.02	1.75	99.93

Thin pats of both cements stood the four-week cold-water test, but in boiling test of an hour and a half, the pats of B were badly cracked while those of A remained sound. To see the effect of heating the briquettes during their hardening on the strength of cement mortars, test pieces which have been allowed to remain in moist air for 24 hrs. were immersed in water of ordinary temp., and then the whole vessel was put in a larger tank contg. boiling water which brought the temp. of the water in the inner vessel to 97–98°C in about $1^1/_2$ hrs. Some of the results are given in the following tables:

TABLE I

		Cement A			Cement B		
		Tensile strength		Crushing strength	Tensile strength		Crushing strength
		Neat cement	Cement 1 Sand 3	Cement 1 Sand 3	Neat cement	Cement 1 Sand 3	Cement 1 Sand 3
Per cent of water used		14.5	7.5	7.8	14.5	7.0	7.5
Temp.	Age of hardening						
97–98°	1 day	32.3	11.0	48.0	..	..	...
97–98°	2 days	75.8	15.9	182.0	75.0	16.4	162.1
97–98°	3 days	84.1	20.3	234.0	86.8	19.8	217.0
97–98°	4 days	66.6	21.0	258.5	93.6	21.0	258.0
97–98°	5 days	72.1	22.0	278.5	77.8	21.9	270.0
97–98°	6 days	73.4	21.4	285.5	78.1	21.1	301.0
97–98°	7 days	77.1	23.1	302.5	76.1	22.5	303.0
8–18°	7 days	66.4	22.5	131.5	61.8	21.0	117.0
8–18°	28 days	68.9	30.3	196.5	65.9	29.0	181.0

Thus, the tensile strength of neat cement mortar, when it is hardened at high temperatures, gets to a maximum within three or four days and then falls rapidly. Similar phenomenon is also observable in cement-sand mortar, though it is by far feebler. Since such an irregularity does not occur in the crushing strength, its test is more reliable

than that of tensile strength. The expansion of these cements hardened at ordinary and high temperatures have been measured:

TABLE II

EXPANSION OF NEAT-CEMENT MORTAR, MEASURED WITH BAUSCHINGER'S APPARATUS, AT 15°C

	Cement A		Cement B	
	Hardened at ord. temp.	Hardened at high temp.	Hardened at ord. temp.	Hardened at high temp.
Time of hardening	0.0303%	0.0808%	0.0287%	0.1442%
3 days	0.0386	0.0832	0.0481	0.1570
7 days	0.0424	0.0674	0.0538	0.1468
14 days	0.0547	0.0694	0.0650	0.1468
21 days	0.0547	0.0694	0.0650	0.1468
28 days	0.0590	0.0688	0.0758	0.1504

The reason why cement B has failed in boiling test for soundness is clearly explained in the table. Besides these, the moisture and loss on ignition of test pieces, made in similar manner, have been determined. S. KONDO

152. Non-slip surfaces. ANON. *London Times Supp.* (Eng. Sec.), **10,** 173(1922). —Non-slip stair-treads, foot-paths, and railway platforms of silicon-carbide and fused bauxite of the Paris Metropolitan Railway have been surfaced with cement with silicon-carbide incorporated present a non-slip surface, show scarcely any signs of wear. The abrasive surface consists of not less than 1 lb. of granulated abrasive incorporated into each sq. ft. of the granolithic surface to the depth of 1/4 in. The granolithic mortar placed to 1/4 in. of the finished surface and into it troweled first a dryer consisting of 1 part abrasive material, 1 part sand, and 2 parts cement; followed by a second dryer consisting of 1 part abrasive material and 2 parts cement, troweled in until at least 1 lb. per sq. ft. of abrasive material is incorporated and the surface brought to proper level. O. P. R. O.

153. Manufacture of Portland cement. T. F. MILLER. *Chem. Trade Jour. and Chem. Eng.*, **130,** 71(1922).—Describes rotary grate shaft kiln. The perfect utilization of the ht. effects a saving of over 50% of the fuel used in the rotary kilns. They can be shut down for several days and started up again without difficulty enabling the closing of the works over week ends and holidays and in slack times. The power required is small in comparison with the rotary type, the grate itself taking from 2 to 3 h. p. The total does not exceed 18 to 20 h. p. including the briquetting press, the feeding device and fan. Descrip. and illus. given. O. P. R. O.

154. Light-weight concrete. ANON. *London Times Trade Supp.* (Eng. Sec.), **10,** 173(1922).—A memoir to the Académie des Sciences, Colonel Rabut, Inspecteur-General des Ponts et Chaussées, refers to exptl. researches on concrete made with slag of considerably lower sp. gr. than that of the gravel and broken stone. Slag concrete is generally stronger, though sometimes a little weaker, than gravel concrete, wt. 30 to 40% less than gravel concrete; ratio of strength to wt. attains max. with sand is from 1/4 to 1/5 that of slag used. Col. Rabut has constructed in slag concrete, the bridge carrying the station Asnieres and the Lestonnat Jetty in the port of Bordeaux. He has recently completed, in the arsenal of Lorient, a large jetty entirely in slag concrete, including piles 65 ft. 6 in. long by 15 3/4 in. square; he has constructed tank wagons and barges of the same material. O. P. R. O.

155. Artificial stones. ANON. *Gewerbefleiss,* **100,** 326–30(1921); *Chimie et industrie,* **7,** 944(1922).—The applications of magnesian (Sorel) cements are continually increasing on account of the great hardness and beautiful white color of the products made from them. Unfortunately, owing to premature setting in contact with moist

air, they can not be stored for any length of time or shipped. This drawback can be overcome by mixing $BaCl_2$ with the $MgCl_2$, and adding enough $MgSO_4$; so that in the presence of moisture the $BaCl_2$ and $MgSO_4$ yield Mg oxychloride and finally pure MgO. The resulting cement is still of a fine white color and can set with suitable amt. of aggregate. The author describes various processes for obtaining fine imitation marbles by using metal chlorides mixed with $MgCl_2$ instead of colored metal oxides. Similarly, natural stones can be given a mottled appearance by injections in the capillary fissures of the rock. A. P.-C. (*C. A.*)

156. Improved continuous-operation pot lime kiln. C. L. NORTH. *Rock Products*, **25**, No. 3, 47–8(1922).—Mostly mechanical. The main point of interest is in the use of a cone-shaped interior of the kiln rather than the usual kiln constructed with Dutch ovens on two or more sides. A diagram and the advantages of this cone-shaped kiln are given in detail. E. F. PERKINS (*C. A.*)

157. Process of improving the quality of mason's hydrated lime. FRANCIS C. WELCH. U. S. 1,410,087, March 21, 1922. The process of increasing the plasticity of mason's hydrated lime, which comprises the grinding of the mason's hydrated lime in contact with a drying agent. C. M. S., JR.

158. Method of calcining gypsum rock and the like. CHARLES R. BIRDSEY. U. S. 1,412,203, April 11, 1922. The method of mfg. gypsum products of different hygroscopic natures by a continuous operation which consists in calcining the crushed raw material, then sepg. the fine material from the coarse, the fine material providing a product of one hygroscopic nature, and finally grinding the coarse material to provide a product of a different hygroscopic nature. C. M. S., JR.

159. Plastic building construction. CHARLES B. SEIDLE. U. S. 1,409,246, March 14, 1922. In a building construction, a vertical double wall, including outer and inner sections affording an air space therebetween, the inner section being formed of horizontal layers of assembled blocks, horizontal plastic beams resting upon the top of the blocks in a selected horizontal layer and terminating substantially flush with the wall of the air space to leave such space substantially unobstructed, filler blocks arranged upon the top of the blocks in the same horizontal layer and disposed upon opposite side of the beams, floor slabs resting upon the filler blocks and terminating substantially flush with the wall of the air space to leave the same substantially unobstructed, and means for locking the floor slabs with the plastic beams, the blocks above the beams and floor slabs resting upon the floor slabs and beams. C. M. S., JR.

160. Wall covering or putty containing magnesium oxychloride. K. WOLF. U. S. 1,418,896, June 6. "Condensed" magnesite is heated to a low glowing temp., slaked after cooling, calcined and mixed with $MgCl_2$ soln. (*C. A.*)

161. Mortar and building-block composition. J. J. LEMON. U. S. 1,418,810, June 6. Ground yellow or white blast-furnace slag 7, sand 1, cement 1, lime 0.07 part and sufficient H_2O to form a moldable plastic compn. (*C. A.*)

162. Plaster mixture. W. T. FELS. U. S. 1,419,665, June 13. A mixt. of ashes 60, plaster of Paris 30, lime 9 and glue 1% is used for finishing walls. (*C. A.*)

163. Composition for building-blocks. F. PATEE. U. S. 1,418,160, May 30. Asbestos aggregate 5–7, portland cement 1, $Ca(OH)_2$ 0.1–0.2 parts are mixed with H_2O and molded. (*C. A.*)

164. Waterproofing cement compositions. G. H. HAVENS. U. S. 1,418,374, June 6. A mixt. contg. hydraulic cement, hydrated lime, slippery-elm bark, alum and $CuSO_4$ is used for building purposes. (*C. A.*)

Official Personnel of Divisions 1922–23

	Art	Enamel	Glass	H. Clay Prod.	Refractories	Terra Cotta	White Wares
Chairman	F. H. Rhead	B. T. Sweely	J. C. Hostetter	C. F. Tefft	J. Spotts McDowell	A. F. Hottinger	F. K. Pence
Vice-Chairman	H. S. Kirk		A. R. Payne	D. F. Stevens	E. H. Van Schoick		
Secretary	M. C. Farren	R. R. Danielson	A. E. Williams	M. B. Greenough	Fred A. Harvey	R. L. Clare	C. C. Treischel
Committee on Research	F. H. Rhead	R. R. Danielson	E. C. Sullivan E. W. Washburn R. B. Sosman *	O. W. Renkert R. T. Stull G. W. Shoemaker Warren Griffis Paul E. Cox R. K. Hursh	R. M. Howe E. N. McGee G. F. Bissell W. E. Dornbach F. A. Harvey S. M. Kier	E. C. Hill Major Gates	F. K. Pence L. H. Bown F. S. Hunt V. S. Schory Ira E. Sproat O. O. Bowman, 2nd August Staudt Leslie Brown C. C. Treischel
Committee on Standards (*a*) Tests (*b*) Products	W. J. Stephani C. F. Binns	E. P. Poste D. F. Riess	(*a*) A. E. Williams W. F. Brown J. H. Forsyth (*b*) A. W. Bitting H. K. Kimble C. W. Parmelee R. J. Montgomery	P. H. Bates W. G. Worcester S. M. Duty R. A. Horning S. Geijsbeek	R. M. Howe E. N. McGee	(*a*) C. W. Hill D. F. Albery (*b*) J. L. Carruthers	H. S. Spurrier F. S. Hunt
Committee on Data	Conrad Dressler	R. R. Danielson	G. W. Morey W. C. Taylor G. E. Barton	H. G. Schurecht	C. W. Parmelee	T. A. Klinefelter	C. C. Treischel
Committee on Membership	W. W. Wilkins	W. C. Lindemann	E. W. Tillotson Jas. Gillinder W. S. Williams	D. F. Stevens H. S. Vincent J. E. Randall H. S. Langworthy J. J. F. Brand	W. E. Dornbach I. A. Krusen A. B. Christopher M. F. Beecher Mark Sheppard M. G. Babcock	W. D. Gates G. M. Tucker A. L. Gladding	Ira E. Sproat
Committee on Rules	F. H. Rhead	J. B. Shaw	W. M. Clark W. A. Yung C. C. Rand	C. B. Harrop R. L. Hare W. W. Ittner S. L. Galpin	E. H. Van Schoick Geo. Fisher	R. L. Clare	August Staudt
Rep. on Committee on Nominations	Paul E. Cox	H. F. Staley	C. O. Grafton	C. F. Tefft	A. F. Greaves-Walker	E. C. Hill	Herbert E. Goodwin
Councilors	Hewitt Wilson W. D. Gates Fredk. Carder Ira E. Sproat	R. D. Landrum D. F. Reiss W. C. Lindemann H. F. Staley	H. L. Dixon C. O. Grafton H. W. Hess J. W. Wright	W. N. Cary E. W. Dailey Geo. A. Bole Eben Rodgers		Geo. P. Fackt W. J. Stephani M. C. Gregory	

* Glass Division Committee on Refractories. D. W. Ross, Chr., C. O. Grafton, A. S. Zopfi, C. E. Fulton.

BULLETIN

of the

American Ceramic Society

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical and Scientific Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

F. H. Rhead, M. C. Farren	Art	J. C. Hostetter, A. E. Williams	Glass	A. F. Hottinger, R. L. Clare	Terra Cotta
B. T. Sweely, R. R. Danielson	Enamel	J. S. McDowell, F. A. Harvey	Refractories	C. F. Tefft, M. B. Greenough	Heavy Clay Products
		F. K. Pence, C. C. Treischel	White Wares		

OFFICERS OF THE SOCIETY

Frank H. Riddle, President
Champion Porcelain Co., Detroit, Mich.
E. Ward Tillotson, Vice-President
Mellon Institute, Pittsburgh, Pa.
Ralph K. Hursh, Treasurer
University of Illinois, Urbana, Illinois
Ross C. Purdy, General Secretary
Norah W. Binns, Assistant Secretary
Emily C. Van Schoick, Assistant Editor
Lord Hall, O. S. U., Columbus, O.

TRUSTEES

Roy H. Minton
General Ceramics Co., Metuchen, N. J.
Forrest K. Pence
Knowles, Taylor & Knowles, E. Liverpool, O.
Fred B. Ortman
Tropico Potteries Co., Glendale, Cal.
Raymond M. Howe
Mellon Institute, Pittsburgh, Pa.
B. E. Salisbury
Onondaga Pottery Co., Syracuse, N. Y.

Vol. 1 November, 1922 No. 11

EDITORIAL

THE VALUE OF DISCUSSIONS

Ability to reason distinguishes man from other animals, and men are distinguished from one another by difference in ability to reason logically, the successful men being those who are most logical. Ability to reason logically is one of the gifts not possessed equally by all men, nor can it be acquired by all to the same degree. Furthermore, no man is equally logical in all lines of thought. Most successful bankers would be less successful lawyers, and most successful works managers would be less successful accountants. Each man has his own calling, but in whatever line a man may be engaged his success will be in proportion to his ability to reason.

Experience has shown that the musician, the poet, the lawyer, the merchant, the works manager, the sales manager and the man in any of the other vocations will attain his greatest ability to reason only by continued orderly practice. Ability to reason in mathematics is acquired only by solving problems; in law by practicing law. Studying and thinking are requisites but reasoning power will be developed only when the things studied and the thoughts evolved are marshalled in an orderly fashion to some definite purpose, as one does when speaking or writing to convince or to make plain to another person. Just as surely as the weak points in design are discovered only in the detailing on the drafting board, so the defects in reasoning are brought out in written and oral discussions.

• Glass Division Committee on Refractories. D. W. Ross, Chr., C. O. Grafton, A. S. Zopfi, C. E. Fulton.

Unless man reasons through to a demonstrated fact he has not acquired knowledge or ability, in fact he will have nothing more than a jumble of experiences. Herein lies the benefit of participating in discussions and in the writing of papers.

Information will be acquired by those who hear or read the discussions and papers but by far the largest amount of definitely acquired knowledge and increased ability will accrue to him who does the telling, especially in debate for in discussion one must focus his experiences and observations in orderly reasoning to a definite conclusion. The reader will have the results but he who has marshalled his experiences, fitting them together to form a conclusion will have derived the greater benefit. It is he who has done the orderly reasoning from premises experienced, rather than he who merely reads or hears, who profits most in increased ability to reason, and it is he who has acquired the greater ability to reason logically who will best succeed in his chosen vocation.

The Silver Jubilee Convention to be held by this Society in Pittsburgh, February 12–16, 1923, and the Bulletin section of this *Journal* offer opportunities for the ceramist who wishes to develop reasoning ability to the maximum of his possibilities. These opportunities are taken by the most successful ceramists. These opportunities are for all who will use them and one so doing can count on the balance in benefits derived being in favor of those who take part in the discussions and of those who write up their experiences and observations.

COLLOQUIUM ON FELDSPAR

Correction

BY V. A. STOUT:[1]—On Page 139 in your August issue, *Bulletin* section, in the Colloquium of Feldspar and Feldspar Grinding, I note that I have made a very serious error in the calculation of the cost of power for grinding in the Hardinge Mill continuous system, as well as in the old system of chaser and batch mills.

This error consists in a decimal point, changing the figures as follows:

193 H. P. hrs. at 1½c per H. P. hr. divided by 3 tons per hr. = 96.5c per ton.

This changes the cost of milling per ton of ground spar for the Hardinge Mill continuous to $2.40 per ton.

By a very peculiar twist, the same error was made on the tabulation of costs per ton of ground spar by the old system and the first item should read:

Power at 1½c per H. P. hr. = $2.00

making these costs $4.90.

PREPARED FOR CERAMIC DAY PROGRAM, CHEMICAL EXPOSITION, SEPTEMBER 15, 1922

The Editor has had conference with a few feldspar millers and users with whom he has met incidentally here and there with the net impression left that the most essential thing is a survey of the user's requirements, the permissible variation in composition, fineness and freedom from coloring and specking material.

The closed circuit continuous grinding provides for splitting the material from the mill according to size of grain, the coarse material being returned for further grinding. This is done for two reasons: (1) to insure that the entire product is ground to the minimum fineness and (2) to lessen the cost of grinding. With batch mills the product is ground under the given conditions of quantity charge and speed of mill until a wet screen test shows a given allowable residue on a 160-mesh screen, no separation of the sufficiently fine from that which is too coarse being attempted.

Practically all of the larger feldspar millers are credited with making a careful selection of the rock feldspar to insure uniformity of product and practical freedom from impurities. Each of them have established the confidence of the large users on the basis of this uniformity. Judging from the tons of discarded feldspar rock at one of the mills which, from casual inspection, appeared to be clean orthoclase, it seems true that the customers' requirements are the criteria of the character of the product which that mill will produce. This discarded feldspar, I am told, is giving satisfaction elsewhere. Hence, I assume that it was discarded at this mill because the product from it varied too much from that to which its customers were familiar.

One user requires two radically different feldspars, (1) easily fusible soda, and (2) refractory potash feldspar. The mixture in which the former is

[1] Received August 9, 1922.

used is not ground to pass a 40-mesh whereas the mixture containing the potash is finely ground. This user, therefore, has two widely varying specifications as to composition and fineness of grind. The soda feldspar used in the 40-mesh batch must be wholly 160 and finer, whereas the "run of mill" of the potash feldspar will satisfy the requirements of the finely ground mix.

One large user has just recently reported relative to tests of feldspar that they have been using Canadian feldspar for some time and that the principal objection has been that they were not ground uniformly although the manufacturers claim to grind to 140-mesh. "In the grinding of our ground coat enamels we grind it rather coarse as we find that we can manipulate the ground enamels best when they are not too finely ground. We usually grind our ground coat enamels to about 40-mesh and we have been troubled with small particles of substance that will not fire down in our muffles, protruding through the surface of the ground coat. Those small particles either make small defects in the finished ware or fall out in the finishing process and sometimes leave a small spot of exposed steel or a small bubble where the white enamels come in contact with the steel."

"After investigation we traced this down to the fact that there were unground pieces of feldspar in the material we have been using. These pieces in some instances are almost as large as small marbles and we find that they do not smelt in the smelting operation. We also find that they are only reduced in our grinding mills and many of these pass through the 40-mesh sieve, and since our ground coat, when it is fired, is not as thick as these unground pieces of feldspar, they protrude through the ground coat and cause the above explained trouble."

"We have purchased small lots of feldspar from several sources and on sieving it we find these unground pieces exist in every lot of feldspar we have purchased from the several well-known sources."

"When the enamels are not finely ground and the coats put on very thin, we find these unground particles are very objectionable."

A manufacturer of vitrified china has made the statement that no sample of feldspar submitted to him recently has been free from dark specks. The specks are not visible to the naked eye in the fused feldspar but are easily seen through a hand magnifying glass.

Another potter has said that he purchases feldspar on price basis from millers who have the capacity and intelligence to produce material that will be uniform from shipment to shipment, because all of them contain coarse material and none are free from black specking material.

Users of feldspar ground in batch, tube, and conical mills have like statements to make regarding the product. So far as is now known, the product has not been sufficiently improved to warrant the expense of air or screen separation of fine from the coarse, nor to attempt to free the

product from the iron impurities. This does not seem logical and it is not logical; there must be misdirected effort prevailing for it surely is true that the millers are now striving to produce quality feldspar.

If samples could be collected from the several producers, examined by petrographers and chemists, and tested thoroughly without prejudice, the ceramic trade could possibly work out practical specifications. With this, however, must be a survey of the quality requirements of the users. Will the feldspar producers and users unite in support of such an investigation?

Standard Specifications for Feldspar

By. W. H. Landers:[1]—It would seem that the discussion on feldspar has reached a point where little further progress can be expected until Standard Specifications are agreed upon. Of course such Standard Specifications will have to be within reasonable limits of the supply of raw material available and the ability of the millers to convert this raw material to these specifications.

Taking the first question, it will be recognized that regardless of whether the feldspar be soda, potash, or soda-lime-potash, the nature of its occurrence is such that the associated minerals, quartz, hornblende, tourmaline, magnetite, ilmenite, garnets and both the micas, will always be present to a certain degree. In many feldspars, graphite, manganese minerals, and sometimes chromite appear. Some unaltered pyrite is also found, although of rare occurrence.

With the long string of the above objectionable minerals, we have, according to whether the feldspar is mined from the surface or deeper deposits, some of the above in various degrees of alteration.

It is recognized that while all of these minerals do not occur at the same time in feldspar of each district, each one of them is supposed to constitute an impurity from the user's standpoint.

In considering Standard Specifications it would be well for the users in each industry to make known as soon as possible just what effect each one of these minerals exerts on their products. There is small likelihood that he is so familiar with this phase that he can at the present time answer this question.

It is also known that the amount of impurities present is the vital factor and that there is available at the present time no quick and accurate method of determining this percentage. This is particularly true of the R minerals of which garnet is the principal offender. What constitutes impurities to one branch of the trade is not necessarily an objection to another branch. For instance, in the glass trade, mica, some garnets and other minerals are not recognized as objectionable so long as the total

[1] Received August 9, 1922.

iron content is kept down to a very low limit. Silica cannot, within reasonable limits, have an adverse effect on the quality of the ware turned out, but enters into the question largely from a price standpoint. Free silica is difficult to determine in the laboratory, but total silica in the feldspar can be satisfactorily limited and this will automatically take care of the free silica question.

It is suggested that the user be liberal in this regard, and that specifications be adopted making more important the question of combined alkali, and limiting the amounts of other impurities.

The original condition of some impurities exerts a great influence on the appearance of the finished product, and the chemical analysis cannot be taken as the whole story. It has been found from experience that certain lots of feldspar from one district, while almost identical in analysis to other feldspars of the same district will fuse white in a biscuit kiln, while the other samples will have a slight brownish tint, both samples having previously given perfectly white buttons, free from visible spots, when fused in a gasoline or gas-fired muffle. These results were the same whether the feldspar had been ground wet or dry, and whether the ground feldspar had been "purified" after having been ground either wet or dry.

Just why this occurs is a matter for further research, and is quoted as tending to show how feldspar taken from one deposit may be expected to vary without visible warning. It has been suggested that this phenomenon is caused by the different degrees of oxidation of the iron minerals, and that when mining is confined to zones where the iron and R minerals are either pretty well oxidized or where they are unaltered, the ground feldspar resulting will be uniformly of one or the other color, *i. e.*, white or slightly brownish.

As this difference may be serious to only a small part of the trade, it is hoped that each of the three great users, manufacturers of pottery and tile, enamel ware, and glass ware, will adopt entirely separate Standard Specifications and that the miller will not be required to guarantee ultimate results when manufacturing within these specifications.

Lime.—From time to time one hears that lime is a detriment to the potter and that both the enamel and glass ware people use lime in their mix. Lime cannot be much of a factor as it rarely shows as more than a trace in the ground or crude feldspar, and is far more likely to creep into the ware, from the use of plaster of Paris moulds. Magnesia is generally present to a greater degree and should be discussed separately from lime.

Potash and Soda.—The question of the predominance of potash over soda, or vice versa is one for the user to decide as the millers in most districts are unable to mine or secure crude feldspar that does not contain both soda and potash.

Alumina.—The value or the effect of alumina seems to be very loosely discussed or understood, and one often hears one user say that alumina reduces the fusing point, and another makes just the opposite statement. They cannot both be right and the discussion should shed some light on this subject. The removal of garnets and mica cannot be accomplished without affecting the alumina contents.

Iron.—Iron in this, as in most chemical products is the "great bugaboo;" no matter what happens, the trouble is blamed on iron. With the exception of the glass trade where the effects of iron are definitely known, it does not seem clear, outside of the question of causing black specks in the ware, just what results from the presence of iron and whether the same effects are secured from the various oxides of iron as are noticed from the occurrence of metallic particles only.

It seems to be definitely established, however, that next to the elimination of iron to start with, its bad effects are considerably minimized by extremely fine grinding.

So far, no one has been able to prevent dark specks completely in the fused samples when these are examined under a magnifying glass. There is no excuse, however, for these specks to be of such a size as to be plainly visible to the naked eye. It represents bad milling practice or the improper choice of crude material.

It is safe to say that while today most of the grinding mills are extremely careful in their choice of crude feldspar, too much is taken for granted in the subsequent treatment of this crude material, and that plain engineering by some one not *too* familiar with the feldspar industry would greatly improve the quality of the product they turn out, especially as regards these iron specks.

Iron gets into the feldspar from many sources outside of its natural occurrence. First, we have that picked up in the mining operations, from the breaking and handling of the material with iron and steel implements. If the wear on these tools is considered, it would calculate too small a quantity to cause concern, but who has ever conducted an operation without noticing the presence in the material of all kinds of tramp metal such as nails, drill points, tobacco cans, links of chain, spikes, hammer heads, rivets, etc.?

When it is remembered that it takes only one small speck of iron to spoil the appearance of an expensive piece of china or tile, it will be realized that this matter is hardly one of definite percentages.

Secondly, as we move the crude feldspar either in mine cars, wagons, or in railroad cars, it is further subjected to contamination, and finally when the crude material gets into the mill, it already contains some considerable tramp iron minerals in the feldspar itself. Cinders from locomotives and hoisting engines, and large pieces of iron rust from open-top

cars, are among the various articles picked out by powerful magnetic head-pulleys, when such a device is used just prior to the grinding of the ore.

To any one who has had experience in the use of magnetic separators of the low intensity type, of which a magnetic head-pulley is a good example, it is at once apparent that the material eliminated at this point represents only the larger and more highly magnetic pieces. From the very nature of the design of the magnet, it can be expected that every large piece of feldspar will be moved aside to allow the feebly magnetic particle under it to be attracted.

There seems to be only one way to handle this problem of iron, and that is to use ordinary, good care in the choice and preparation of the crude material for the mill, and then to use such devices or processes in the milling, as will eliminate such iron either magnetic or non-magnetic, as may be enough to cause visible specks in the fused ware, without the use of a magnifying glass.

Considerable discussion has already taken place on the respective merits of sledging, followed by chaser stones, as against breaking in rock crushers, followed by further reduction in conical or cylindrical mills. It is a very difficult matter to exactly determine just how much iron is added in either case; the principal trouble being to take accurate head samples before the crude is reduced to a comparatively finely ground state. Measurements have been taken with great care, and over long periods of time, of the wear of jaw crushers when operating on various harder and softer rocks than feldspar, and some figures are available, as to the weight of metal worn away per ton crushed in the feldspar industry. This is so ridiculously low that one is inclined to question whether there is not actually as much iron added to the feldspar by hand sledging, plus the occasional broken hammer, and by the gears of the chaser stones, as may come from the more economical, and in every way more desirable rock feldspar.

It would be interesting to get an analysis of some of the chaser stones now used.

Passing these preliminary stages of coarse crushing, it will be seen that intermediate grinders, such as conical or cylindrical mills, have very little chance of adding any iron when lined with silex: this same applies to tube mills, either continuous or batch, although any one who has taken the gratings off the dump holes of batch mills and thoroughly cleaned them out is frequently surprised at what is found inside, in the shape of nuts, bolts, etc., that seem to have no reason for being there after all the agonizing care that has been taken to keep the feldspar away from iron.

During the milling process, the most prolific source of iron is from the types of conveying machinery generally used. Again we have the apparent necessity for the careful engineering of these problems by some one who is

not willing to accept present practice solely on the theory "that most mills have always used such."

As it is not the object of this contribution to enter into the respective merits of the various types of machinery, wet or dry grinding, or other factors such as costs, entering into the preparation of feldspar to meet Standard Specifications, this seems a good point to turn to the next mineral found in feldspar.

Mica.—Mica as generally found in feldspar is of two kinds: the muscovite, which is chemically harmless, and the biotite, which may contain iron either chemically combined or as isolated pieces of oxide between its laminations. One or both of these micas is always present in feldspar, and it becomes a question as to how much, or rather, in what form, mica can be permitted in the finished product.

Some members of the glass trade have stated that the presence of mica, other than its influence on the iron content, is no detriment in any form, but as much of the mica is practically infusible under conditions met in the pottery and enamel traces this question is reduced to that of how coarse can mica be permitted in the specifications.

It is entirely practical to eliminate most of the mica at certain stages of process, while grinding wet, but no way has been found to get it out in the dry state. As most of the feldspar comes at present from dry grinding plants, they will be chiefly interested in the fineness permitted.

Garnets.—So many types of garnet occur in practically all feldspars, that this question becomes one of prime importance. Most garnets are more fusible than the feldspar itself and have the objectionable property of spreading through the semi-fused enamel or glaze, and while not causing clearly defined spots, like iron, do result in somewhat off-color ware.

This problem of garnets will be one of the hardest to settle in adopting specifications, as there is no way of determining the exact percentage of garnets present. All garnets are not even slightly magnetic, but as they readily concentrate in a vanning pan, some method of estimating their amount may be developed; this has been done with approximate results by the miner in free gold mines, to determine the amount of gold in the ore.

The amount present can be substantially reduced in either the wet or dry state, but never can be entirely eliminated. How fine the remaining garnets are, can have little bearing on account of the lower temperature at which they fuse.

Tourmaline and Hornblende.—These are both silicates of the R series and may or may not cause off-color ware. For this reason, they form two of the objectional impurities in certain districts. It is barely possible that the allowable amount of these can be controlled along somewhat similar lines to garnets. This has been done quite successfully in a laboratory

way, but there is no available knowledge of a successful effort being made to reduce or eliminate either of these on a tonnage basis in process.

Coal Dust and Cinders.—These, if low in iron, seem to have no bad effect, but it is not definitely known just what part native graphite may have in producing off-color fusions; this matter can easily be determined by simple research, and should the graphite be objectionable, its almost complete removal can readily be accomplished in process.

Moisture.—The foregoing discussion covers only the question of impurities that may be present in the crude ore or picked up in process. There has lately developed a question of moisture or dryness, with the attendant one of lumps on the ground product.

As these lumps are composed of most finely ground feldspar and are only loosely cemented together by the small amount of colloidal matter present, they present a problem only to some of the enamel ware people. The finer the product is ground, either wet or dry, the more lumps will appear in the finished material when received.

Lumps are not peculiar to wet-ground material, but as their size, if not disintegrated before shipment, is more apparent, there have been some complaints on this score.

Many tests on dry-ground feldspar have indicated, especially when very fine, that depending on the humidity, it can be expected to take up from $^1/_2$ to $1^1/_2\%$ of moisture from the air, particularly when loaded warm.

Feldspar, when ground to pass 140-mesh, dusts very badly in handling but it contains less than 2% moisture, and this suggests that it might be much to the advantage of all concerned as tending to prevent losses and injury to the health of the workmen to allow, if not actually to require, from 2 to 3% moisture in the ground feldspar when received. Some states will undoubtedly legislate against *unnecessary* dust in this, as they have in other business.

The question of unground lumps will be discussed under the next topic, the all-important one of fineness.

Fineness.—Requirements as to fineness must be considered from the users' standpoint.

The *potter* can secure his feldspar ground from all of the present mills so that less than $^1/_2$ of 1% remains on 140-mesh Tyler standard screen. In some processes, what remains on 140 will be practically all mica which has previously gone through 100-mesh screen.

It is practically impossible where batch grinding is used, to guarantee the absence of large unground pieces, particularly bits of grinding pebbles, but in this case the balance of the feldspar will be much finer than 140-mesh, in order to average down the weight of these larger pieces.

There is no limit except that of time and cost, as to how fine feldspar can be ground, although it is a difficult matter to satisfactorily get a finer prod-

uct than that above, by the use of air separators operating in closed circuit, or by the use of screens which becomes impractical to the dry grinder, when he must use finer than 50-mesh cloth. These statements are not meant to imply that finer results cannot be attained when using air separators or screens, but that it would be impractical to do so with any hope of marketing ground feldspar at the present or a reasonably higher cost.

A very important specification would be a clean-cut adoption of some standard test screen, such as the Tyler Standard or a U. S. Standard; both cannot be used as there is quite a difference in the size of particle going through a given mesh in each.

Methods of grinding influence the range of sizes, but in general, if $^1/_2$ of 1% remains on 140, there will not be over 5% on 200. It would seem better to adopt as coarse a mesh as possible and reduce the amount allowed to remain on this in order to facilitate the making of screen tests, both at the mill and at the plant of the consumer; very fine mesh test screens are costly to buy, do not last long before becoming inaccurate, and consume too much time in their use.

Some potters propose to use a rising current of water of definite velocity as means of determining fineness. This will not do at all as a standard, for the reason that different feldspars settle at vastly different rates, according to the shape of each particle, which shape is somewhat influenced by the grinding method used and the amount of impurities present. A wet-ground feldspar may settle as fast as five times the rate of a dry-ground feldspar and yet both will give identical results on a complete screen analysis. A few degrees of temperature may greatly change results as may the presence in the water of various mineral salts or organic matter.

Test screens with a definite opening will give the only positive results, unless the potters demand feldspar ground finer than 200-mesh; this fineness can be practically attained only by grinding in water.

It is recognized that some potters may demand a different fineness for use in the body to that necessary for use in the glaze, but it would seem far more satisfactory for each user to put in his own equipment to take out some of the very fine feldspar for the glaze from his standard feldspar, leaving a residue free from colloidal matter and most likely in a better state for working up in his clays and other materials that enter into the body.

The *enamel* trade, from what little can be gathered (mostly from their complaints), would like to get a feldspar free from lumps, which would leave no residue on an 80-mesh screen, and contain no material finer than 250-mesh. Such a feldspar would be in the nature of an extremely fine sand, would contain no lumps of any description and would fuse far more easily than feldspar containing finer material which would tend to form lumps during their process. This feldspar would be an intermediate size

but might be difficult to produce at some of the present mills. It is worthy of discussion, however, as it is possible to produce such a feldspar at a reasonable cost.

An intermediate size such as this would contain fewer impurities than either the coarser or finer products.

This same trade at present is generally supplied with feldspar ground to pass a 40- or 50-mesh vibrating screen set on a steep angle, which gives a fineness of approximately 90- to 100-mesh, but it does not guarantee that it will not contain quite a few pieces of 40- or 50-mesh material. The air separators on this product give about the same result.

The *glass* manufacturer uses comparatively coarse glass sand, some as coarse as 30-mesh, and it would seem that there would be no objection to their using feldspar of approximately the same fineness.

They could quite profitably use feldspar which had passed through 40-mesh but remained on 100, and contained not over 10% finer than 100. Such a feldspar sand can be very cheaply produced on a tonnage basis, will give very little dust in handling, and will be naturally of low moisture content.

It can be brought down to a very low iron content, and although it might contain considerable mica, 30-mesh and finer should be satisfactory for their use especially where price and tonnage play such an important part.

There is an almost unlimited quantity of crude feldspar available that can be milled to meet any reasonable specification, where white opaque fusion is not required, and the allowable silica and iron content be over 70% and 1%, respectively.

As stated at the beginning of this contribution, its object is to further the adoption of Standard Specifications or at least to promote helpful discussions of this subject.

The user can be concerned only in securing a suitable feldspar at a reasonable cost and should try to get adopted for his branch of the trade, a set of specifications under which it is practical to produce ground feldspar from the sources available, and by milling methods which are considered practical in a modern way.

Just so long as no Standard Specifications exist, there will be unsatisfactory and un-uniform feldspar produced with a steadily mounting cost to the consumer and possible bankruptcy to the miller.

Adjusting differences between the miller and user is one of the largest items entering into the present cost of producing ground feldspar. Too often does it occur that shipments are refused for no other reason than the shop superintendent's prejudice against the appearance of the raw feldspar. A few simple laboratory tests would indicate that this feldspar was as good as any previously used. Few millers have to date produced feldspar that is always of the same color, fineness, or moisture content.

When feldspar is ground to a definite specification, the manufacturer receiving this feldspar should be obliged to accept at least that shipment without further expense to the producer.

It will be time enough when standards are adopted to improve present milling practice or develop new processes.

By Raymond B. Ladoo:—This paper by Mr. Landers is very timely as it goes to the root of much of the trouble which has been found with commercial feldspar. It is very necessary that both the feldspar producer and the consumer agree upon standards of feldspar for various uses, not only upon grades but upon types of feldspar and fineness of grinding. This subject must be approached, however, with great care for opinions as the needs of individual consumers differ widely. There are also considerable differences in feldspar deposits.

Specifications to be workable and satisfactory to both producers and consumers, must be formed by the joint action of men of wide experience, representing both producers and consumers. Standards set up by only one side or one phase of the industry have often been found unworkable and a source of trouble rather than a help. Wide experience is needed for conditions of production and consumption differ so greatly in different districts that generalizations based on experience in one field only are often dangerous and misleading.

The terms "standards" and "specifications" have been used rather loosely at times with the result that at present they do not always convey the same meaning to different people. Of course absolute standardization of feldspar in the sense that is implied in the standardization of screw threads, of rail sizes and weights, etc., is impossible. Instead an attempt should be made at first to draw up specifications for different uses giving rather wide tolerances. Such specifications might mention the most acceptable fineness of grinding, the total alkali content, the maximum allowable iron content, or whether or not impurities such as tourmaline, hornblende, garnet, pyrite, biotite, etc., shall be tolerated. It would be expected that these specifications would be revised at stated periods improving them and making them more specific as knowledge of production and utilization increases.

The following comments are based on Mr. Landers' paper:

On page 271 it is stated that the common minerals associated with feldspar, for example, quartz, hornblende, tourmaline, etc., "will always be present to a certain degree." While it is true that most pegmatite deposits contain some or even all of the minerals noted it is often the case that these minerals are segregated along the walls or in other portions of a deposit and are not mixed with the massive feldspar. Thus it is sometimes possible to mine feldspar almost entirely free from any visible impurities.

In other cases it is possible to mine large bodies of feldspar which contain only quartz as a visible impurity. Portions of the dike carrying other impurities in such cases are left standing in the mine. Very large quantities of crude commercial feldspar are obtained which are practically free from the objectionable impurities noted.

On page 271, Mr. Landers mentioned "the R minerals, of which garnet is the principal offender." It is not quite clear what is meant by the "R minerals," but I assume reference is made to the complex silicate minerals which contain iron, manganese, and magnesium in varying proportions. While it is true that in some instances garnet is the principal impurity of this type, in other deposits garnet is subordinate or absent and tourmaline is the chief offender. In other cases hornblende or biotite or beryl occur in abundance and render feldspar worthless under present conditions. This is an important point because garnet, on account of its high specific gravity, may perhaps be eliminated by some system of mechanical concentration. Hornblende, tourmaline, beryl and biotite are too close to feldspar in specific gravity to make possible successful gravity concentration.

The problem of determination of free silica is difficult but it cannot be solved by merely determining total silica. The somewhat common practice of using total silica content as an index of the free silica content is incorrect and misleading for the reason that the different feldspars have different alkali-alumina-silica ratios. Pure potash feldspar (microcline and orthoclase) contains theoretically 64.75% SiO_2; pure soda feldspar (albite) 68.8% SiO_2; and pure lime feldspar (anorthite) 43.2% SiO_2. Thus it is possible to have a high total silica content with a low free silica content and it is also possible to have a low total silica content with a fairly high free silica content. Various types of pure feldspar, therefore, may vary in total silica content all the way from less than 50 per cent to about 69 per cent without containing any free quartz. In actual practice the only method of determining free silica (and this is only approximate) is first to make a complete analysis, and second to calculate from this analysis the mineralogical composition based on the amounts of alkalies and alumina present. The total silica required by each of the feldspars and by kaolin, if present, should be added together and this sum deducted from the total silica as given in the complete analysis. An actual calculation based on this method showed that in two analyses of the same feldspar the difference in total silica was only about 3% whereas by calculation the difference in free silica was about 12 per cent.

In the discussion of the effect of alumina, free alumina must be meant as the alumina in feldspar is a component part of the mineral and in quantity it bears a definite and unchanging ratio to the alkali of the feldspar. Any excess of alumina not required by the alkali present is usually considered

as kaolin (in a feldspar free from mica, garnet, etc.) due to greater or less alteration of feldspar. Sometimes this alteration is not visible to the unaided eye but is plainly visible under a microscope. Thus free alumina is rarely, if ever, present in feldspar. In pure feldspar any variations in the alumina content must mean a proportionate variation in the alkali content.

On page 273, it is stated that it has been impossible to eliminate completely dark specks in fused samples of feldspar when these are examined under a microscope. This is probably true of feldspar which originally contained impurities, but when a pure feldspar is fused black specks can be introduced only by careless handling either in preparing the material or in firing it.

I agree entirely with Mr. Landers' conclusions that iron may get into the feldspar from many sources so that feldspar which is iron free in the quarry may contain considerable iron before it reaches the potter. Precautions must be taken in mining, transporting and milling feldspar in order that iron may not be introduced, and if introduced may be removed during the milling process. However, as noted by Mr. Spurrier in a previous discussion, feldspar which is delivered to the potter in a practically iron free condition may pick up considerable quantities of iron in the pottery. The question of iron, therefore, is one which cannot be settled alone by the feldspar producer but part of the burden must rest on the consumer.

It is stated that mica, either muscovite or biotite, is always present in feldspar. In some districts this is true, but in some deposits in other districts feldspar practically free from mica can be obtained in quantity, in some cases easily and in some cases only by careful mining and sorting. Therefore, mica is not to be considered always as a necessary impurity. It has been commonly assumed that muscovite mica is chemically harmless but this is not always true. Muscovite is a mineral of variable composition; sometimes it may be iron free but in other cases pure muscovite may contain a considerable quantity of iron. Thus one analysis of a typical North Carolina muscovite mica shows about $2^1/_2$ per cent Fe_2O_3. This may be a source of iron which is sometimes unexpectedly found in feldspar. It is stated that mica is practically infusible under conditions met with in the pottery and enamel trades; but Watts[1] states that while muscovite alone fuses at cone 13, fine ground muscovite in potash feldspar lowers the deformation temperature and that the rate of deformation increases with increased proportion of muscovite.

Garnet, as noted previously is not found, at least in large quantities, in all feldspar deposits. Therefore, the problem of elimination of garnet is not common to all feldspar producers. It does not seem necessary to at-

[1] Watts, A. S., "Mining and Treatment of Feldspar and Kaolin," *Bureau of Mines Bulletin*, 53, page 29.

tempt to define the permissible amount of garnet in feldspar for the color and appearance of fusion test pieces should govern in pottery feldspar, and the total iron content, as shown by analysis, in a feldspar for the glass and enamel trade. It should be possible to set up standards of color for fusion test pieces just as it has been possible to standardize color in white pigments and other materials where a pure white color is essential.

The problem of the separation of tourmaline and hornblende is a serious one and one which has not been solved. The specific gravity of tourmaline varies from 2.98 to 3.20; hornblende 2.9 to 3.4; feldspar 2.44 to 2.8 and garnet 3.15 to 4.38. It is evident that while the differences in specific gravity between feldspar and garnet are sufficient to allow a fairly complete separation by gravity methods the differences in specific gravity between hornblende, tourmaline and feldspar are small and are not sufficient to permit a successful mechanical concentration. The elimination of tourmaline and hornblende must, therefore, await the development of new and better methods of concentration.

On page 276, reference is made to the fine grinding of feldspar and it is stated that it is impossible to produce very fine ground feldspar commercially by the use of screens or air separators "at the present or a reasonably higher cost." While the economical use of screens for this purpose has not yet been definitely proved I think it has been definitely proved in a great many cases that very finely ground materials, not only feldspar but many other materials, can be separated successfully by the various systems of air separation now in use. The use of air separators for the classification of extremely fine ground materials has grown very rapidly within the past few years and the success of such methods cannot be questioned.

The present methods of determining the fineness of feldspar are somewhat unsatisfactory in that a determination of fineness is usually made on but one screen, the 140- or the 150-mesh. Grinding tests on many different types of material including feldspar have shown that two materials may show almost identical results on one screen but still contain very different proportions of extremely fine material. Thus, for example, two materials might show both a residue of only one-half of one per cent on a 140-screen, but one of these might show 50% on a 250-mesh screen while the other might show only 1% on a 250-mesh screen. Therefore, in order to obtain an accurate estimate of the fineness it is necessary to use not only a limiting screen but one or more screens which are much finer, or it is necessary to use some method of elutriation which will determine the relative amounts of grains of the different sizes. This method of determination of size by elutriation is slow and is often not necessary, but it usually gives accurate results on a material like feldspar. Feldspar ordinarily possesses a good cleavage and the shape of grain in fine grinding depends more upon this cleavage than upon the method of grinding. In the case of materials which

do not have a good cleavage the shape of grains is often influenced greatly by the method of grinding. While most present specifications for feldspar are based on a fineness of 99½% through a 140-mesh screen it is evident that most potters desire a large percentage of very fine material. It is suggested, therefore, that not only the 140-mesh screen be used but in addition the retention on a 300-mesh screen be specified.

It is stated that "a wet-ground feldspar may settle as fast as five times the rate of a dry-ground feldspar and yet both will give identical results on a complete screen analysis." It is important to know in this connection what was the finest screen used in this complete screen analysis and what were the relative amounts which were retained on and which passed through this finest screen. In these tests it is probable that some of the material was in a colloidal state and that the presence or absence of coagulating or settling reagents had more effect on the rate of settling than the absolute fineness. This matter should be investigated further and, if it is found that colloids have an appreciable effect on the rate of settling in feldspar elutriation tests, then any standards based on this method of testing should provide for the reduction of all samples to the same colloidal condition, that is, all samples should be treated either entirely free from settling reagents or should have definite amounts and the same amounts of such reagent present.

It seems probable that for most purposes the determination of fineness can be made best by the use of several screens of which the finest should be 300-mesh (or finer if obtainable).

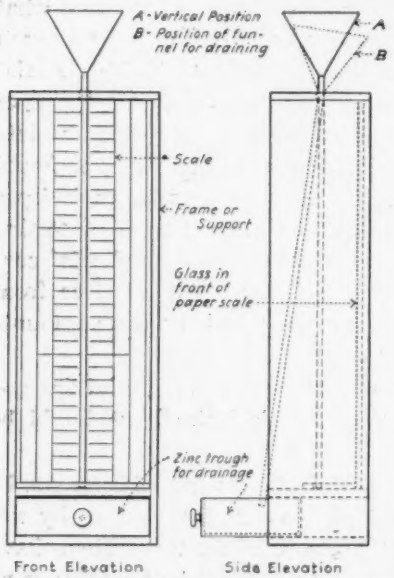
While it has been demonstrated that very finely ground feldspar can be made commercially by dry grinding and air separation as well as by wet grinding, the relative costs and the relative merits of the two systems have not yet been established. It is conceivable that it will be found in some instances that dry grinding methods will be preferable and cheaper and in other instances wet grinding methods will be more suitable.

The whole subject of feldspar specifications for various uses should be gone into very carefully by a committee composed of both producers and consumers of feldspar. Mr. Landers' paper has pointed out the need for such work and I am heartily in accord not only with his efforts, but with his major conclusions. It is to be hoped that definite action may be taken on this subject soon.

Method and Apparatus for Quickly Determining Fineness of Grind

By Eric W. Turner:—When such materials as feldspar and flint are ground in the intermittent type of pebble mill, the determination of the finishing point has always contained the element of chance to an appreciable degree.

A mill of a certain length and diameter, revolving at a given speed and containing a certain weight of pebbles, will grind a standard charge of crude material to the required degree of fineness in a certain number of hours. So long as the physical characteristics of the crude material remain uniform the period of grinding will remain approximately constant. However, should these characteristics fluctuate the period of grinding will vary accordingly. This factor has always been controlled by the man in charge of the operation. For instance, if the crude material is damper than usual he would cause the grinding period to be lengthened out. On the other hand, if the material was dryer than usual the grinding period would be shortened.



Apparatus for Determining Fineness of Grind

FIG. 1.

While the material has been ground supposedly to specification there has been no method for rapidly proving with practical accuracy that such is the case. The method of rubbing between the fingers or of biting it between the teeth is unreliable while the standard screen test is not applicable owing to the length of time each mill would be held up while the test was being made.

A shop test to be practical must be simple, rapid and economical so that it can be performed by the mill foreman without hampering production. In order to fill the want of such a test the following method and apparatus have been devised.

It is assumed in this description that the required degree of fineness is not less than 99% passing through a 160 brass screen of the Tyler testing type.

The cap is first removed from the mill and a suitable quantity of ground material extracted by means of a long handled dipper. From this sample 300 grams are weighed out on a rough pair of gram scales. A set of ordinary spring scales of the household variety is satisfactory. The sample is then transferred in the dry state to the test screen and the fines washed through with a stream of running water. The residue is rubbed with a camel's hair brush to make sure that no fines remain on the screen. The fines are allowed to run away as it is only necessary to determine the per cent of coarse residue. This is determined directly in the simple volumeter which is illustrated (Fig. 1).

This consists of a glass funnel with a long stem, a suitable support and a vertical scale graduated in tenths of a per cent. The end of the stem is closed with a small cork stopper. The only other accessory equipment is a wash bottle. The ordinary laboratory wash bottle has been found to be too light to stand the rough usage it gets in the shop and in place of this a pint milk bottle is used fitted up in the usual manner.

The stem of the funnel is first filled with water and all air bubbles removed by means of a piece of straight wire. This procedure is necessary, otherwise the funnel will become clogged. The residue is then transferred from the screen to the funnel by use of the wash bottle. The residue will pass very rapidly from the cone down into the stem and when settlement is complete the percentage rejection can be read directly from the scale. If this is less than 1% the mill is discharged, if greater than 1% the cap is replaced and the grinding continued. The funnel is easily cleaned out by simply removing the stopper and allowing the material to drain into the pan which is provided for the purpose. The time required to make this test is less than three minutes.

In calibrating the scale it has been found advisable to have the distance between the one-tenth per cent divisions as great as possible to permit of rapid and accurate reading. When the percentages are calculated on the basis of a 300-gram sample the scale divisions are sufficiently large to provide for this and it is for this reason the 300-gram sample is used.

To calibrate the scale, a small quantity of coarse residue is accumulated and dried. From this three grams are accurately weighed out. This quantity then represents 1% of 300 grams. This is placed in the volumeter and allowed to settle for two minutes. The head of the column is then marked off. This height then represents 1%. This is divided into ten equal parts each of which represent one-tenth of one per cent. The scale can then be extended by means of dividers to any desired length or to conform to the length of the stem. When more than one funnel is to be used it will be necessary to calibrate each one separately as the variation in the inside diameters is quite considerable.

With this method no attempt is made to attain scientific accuracy but the results are sufficiently accurate for all practical purposes. Of course the residues from materials whose specific gravities are widely different could not be determined on the same scale but for materials such as flint, feldspar and glaze the results from one scale are accurate enough.

By George M. Darby:—The Dorr Company apparatus would have quite an application in the classification and dewatering of ground feldspar and considerable tests have been carried out at our Westport Mill to determine the sizes of units necessary for such separation and dewatering. We grind the feldspar wet and can easily make a classification at

200-, 300- or 350-mesh. The problem then is to dewater the fine feldspar.

The material is in a finely divided condition and will not settle readily. It is deflocculated, that is, dispersed. To coagulate or flocculate the solids requires some electrolyte.

After a large amount of research we have found that *lime* is the only electrolyte which has an appreciable effect. But the mere mention of the name *lime* to a ceramic engineer condemns its use as a coagulant. The amount we use is very small, an average of 5 pounds lime per ton of feldspar dewatered. The bulk of the lime is removed when the water is decanted, only a very small part of the lime remaining with the feldspar. For example: Assume a feed to a Dorr thickener to be 15 tons water, 1 ton of feldspar and 5 pounds of lime. The feldspar settles to a dilution of .5 to 1 (33% moisture). Then 14.5 tons of water have been decanted, and with it $\frac{14.5}{15} \times 5$ lbs. of lime in solution. Only $^1/_{30}$ of the original 5 lbs. of lime (or .17 lbs.) remains with the feldspar.

Figuring .17 lbs. of lime remaining with the feldspar it gives 0.0085% lime in the feldspar.

By George M. Darby:[1]—I appreciate your letter and "Colloquium on Feldspar." It gives us great satisfaction to have you voice the opinion that the slight additional amount of lime adsorbed from the flocculating agent would not be harmful.

This discussion definitely indicates the lack of uniformity in the prepared feldspar. In batch grinding or open circuit grinding one cannot hope to secure a uniform product. But in closed circuit grinding in which the material which has been ground to the desired fineness is being removed continually, and only the oversize is returned to the mill, a uniform product of a certain size is readily obtainable.

Dry grinding in conjunction with air or screen separation is more expensive than wet operation.

To produce a product finer than 100-, 200- or 300-mesh we would operate a bowl classifier in closed circuit with a tube mill or conical mill (grinding wet). The 100-, 200-mesh or 300-mesh feldspar would be overflowed to a thickener for dewatering (with slight addition of lime to assist flocculation and settling) and the feldspar coarser than 200-mesh or 300-mesh would be returned to the mill along with fresh feed for further grinding. The thickened feldspar would then be dewatered further on a continuous filter, and the filter cake fed to a dryer.

Reply to Mr. Darby by W. H. Landers:—Mr. Darby's comment on the necessity of providing a coagulant if feldspar is to be settled within a

[1] Received July 19, 1922.

reasonable time previous to or during dewatering, is borne out by actual milling operations.

Many careful observations of the action of very finely ground feldspar in water, have caused me to believe that fineness alone does not greatly retard the settling of feldspar, although it is quite apparent that the coarser the feldspar particle, the quicker it will settle.

The feldspar which fails to settle promptly, is not necessarily finer than that which settles within a reasonable period, but it has not been proven that the permanently suspended matter is altogether in a colloidal state.

Chemical analysis of the two materials does not indicate a conclusive difference.

Lime will coagulate all of the visible solids, and acts in other helpful ways during the process of wet grinding.

It cannot be used indiscriminately without causing some mechanical difficulties, but is so far, the best settling agent available.

In actual practice, a far less quantity than 5 pounds of lime per ton of feldspar dewatered, gives the desired result, and many chemical analyses made on both the raw feldspar and the finished product, show no more than a trace of CaO.

This small amount can have no influence on the subsequent use of the ground feldspar, especially when it is realized that many use lime to a more or less degree.

BY O. O. BOWMAN, 2ND:—The subject of "Feldspar and Feldspar Grinding" is a very broad one and one that appeals to me very much. My interest in feldspar began when the matter of getting good, ground feldspar during the war times was practically impossible. Further than that, the price of the material was exceedingly high for the quality received. Therefore, we thought it would be advisable to go into the grinding of feldspar for our own use. I made a trip to Canada, visiting a number of mines in the Verona section of Ontario. Among the mines in this section and one that had the greatest reputation for producing some of the finest feldspar in Canada was the old Richardson Mine.

I was able to obtain enough feldspar for our own use. This feldspar was all bought as strictly No. 1 grade feldspar. All cobbing was to be done at the mines so that the material received at our plant was ready to be ground and no cobbing would be necessary. I was able to obtain a very good grade of feldspar at a price that would allow me to grind the material and have a finished product with a saving of about three to four dollars per ton. Had this feldspar cost me exactly the same as the ground feldspar, I would still feel that I was ahead of the game. The reason for this was that one saw the actual material that was used for the ground feldspar, knew the length of grinding time and could regulate the fineness to re-

quirement. If there was any trouble with the feldspar, it would be one's own fault. Further than that, by buying the crude feldspar, it was possible to carry a six months' supply and we often had as high as three hundred to three hundred and fifty tons of feldspar on the ground.

I must explain that we did not equip ourselves principally to grind feldspar. We already had a unit which was grinding a product for us but this unit was only running on a 50 per cent capacity inasmuch as our supply of the material did not warrant any larger production, so that by grinding feldspar, we cut down our overhead on this unit and the cost on our feldspar and the other material we were grinding. Our unit for grinding consisted of three chaser stones and two two-ton ball mills of Thropp manufacture. By running this unit 50 per cent on feldspar, we were able to produce enough ground feldspar for our daily use and keep a small stock.

As explained above, our method of grinding is not elaborate nor did we change anything for the grinding of feldspar, although I am satisfied that we can very well make a small change and save considerable in our grinding cost, such as by putting in a rock crusher and special conveyors. Our feldspar is first put under chaser stones where it is crushed and put through a $^1/_4$"-mesh screen. The tailings of this are put back under the stones and the product goes directly to ball mills and is ground for seven hours. Our product at end of seven hours gives us a feldspar equal to any feldspar purchased on the market today for fineness and quality.

I have visited a number of grinding plants. In the most efficient equipment, the Hardinge Mill is being used and from the information which I can obtain it is going to replace the intermittent mill in a number of places.

There is a great deal that can be said about the grinding of feldspar and inasmuch as we are not grinders of feldspar, I will leave it to the grinders to write their own discussions. However, the time is coming when the grinders have got to produce the quality and the manufacturer will have to pay the price for good material, but he is going to be willing to pay the price for the material provided he obtains what he is paying for.

By C. R. Moore:—The writer has followed with interest the various discussions on feldspar grinding and having investigated various grinding methods for reducing the material is making the following comments on the colloquium:

The answer to the first question by Mr. V. A. Stout that dry grinding can be performed as cheaply as wet is very reasonable but from a miller's standpoint the dry process has much in its favor. If it is advisable for efficient operation in dry grinding that the material be dry within one per cent of moisture, it is obviously cheaper to remove the 5% or 10% moisture from the incoming feldspar than to remove the 35% or 40% that has to be added for wet grinding.

This statement is based on the fact that the relative efficiency of a grinding unit wet and dry, while probably favoring the wet very slightly would be offset considerably by the increased cost of drying.

The logical method of drying the wet-mill product is by feeding it to a rotary continuous filter and removing as much moisture as possible by vacuum. This type of filter consists of a large wheel four to six feet in diameter and a face of from one to ten feet. The face or perimeter is covered with canvas and the wheel rotates in the slurry up to about one-third its height. Suction applied through pipes inside the wheel removes the moisture, the solids forming a cake on the perimeter which is removed by a scraper as the wheel rotates.

The moisture content of the cake is probably about 15%. This must then be conveyed to a drier for the removal of the remaining moisture. This drier, if of a continuous type which, of course is desirable, is liable to cause iron contamination which is objectionable.

There is a device on the market admirably adapted for this drying which would eliminate this iron. It consists of a woven wire belt mattress of the same width as the face of the filter. This belt rotates with the filter, on its face and the cake is built up in the mesh of the belt. The belt conveys the cake from the filter to the dryer, through which it is carried continuously until it is as dry as required.

The resulting cake is granular and dustless, readily disintegrates and yet is very convenient for handling.

These methods should be of interest to millers on account of this continuous action as compared to the intermittent action of filter presses, but their initial expense is high.

For the potter who produces his own feldspar, wet grinding should be desirable, especially if the incoming feldspar is fairly high in moisture, as drying can be omitted. In this case the finished feldspar can be pumped to agitators and measured wet. The solids per gallon are readily determined from the specific gravity of the slurry and solids. The effect of evaporation is small and can be readily corrected.

The objection to this method is the space required for storage and the constant need of agitation. If this agitation is as slow as possible iron and large grains of feldspar tend to settle and can be periodically removed which is quite an advantage. From the miller's standpoint, however, this method is out of the question on account of the shipping difficulties and to get the finished product in a dry state as cheaply as possible is his problem. Dry grinding, therefore, inasmuch as it omits the expensive drying operations, has much to recommend it to the miller.

In the opinion of the writer the grinding activities of large mining companies cannot be over emphasized in their relation to other grinding problems. The actual grinding of feldspar presents no difficulties that

have not been already surmounted by various mining companies and the results of their work are published freely.

With this fund of information at the disposal of millers it is more or less fool-hardy to duplicate expensive tests that have already been performed on ores similar to feldspar.

It has been proven many times that in a cylindrical tube mill of 22 feet in length, approximately 90% of the material is reduced to the required fineness in the first four or five feet of mill, the other seventeen or eighteen feet being necessary to reduce the remaining 10%. As the power used is in direct proportion to the length it is obvious that three or four times as much power is required to reduce 10% of the material as was needed for 90%.

This is due to the cushioning effect of the already ground material on the pebbles, making it difficult to concentrate a forceful blow on the coarser material.

In the case of batch mills the same action is apparent.

The biggest proportion of the mill charge is reduced to the required fineness in possibly less than a fourth of the total time required for the reducing of the whole charge. This is also because of the cushioning effect of the fine material.

The outcome of these tests has been the closed circuit system of grinding which is now standard in nearly all mining operations.

The mill length has been cut to about a fourth of its former size with a consequent large saving in power and the resulting cost per ton of ground ore is decidedly cheaper than with the old methods of open circuit grinding.

For fine grinding the short cylindrical or conical mills have replaced other types. The chaser mills are almost relics of the past where efficient operation is concerned.

The removal of impurities in the ore is a question of great concern to millers and undoubtedly this is difficult of solution in the case of quartz and mica except by hand packing.

Metallic impurities due to their high specific gravity can be removed by concentrating tables such as are used in mines, but quartz and mica do not lend themselves readily to this method on account of the similarity of their weight to that of feldspar.

There are on the market concentrating tables for both dry and wet processes so that use of a table does not compel one to adopt the wet method of grinding.

The copper sulphite, which Mr. Everett Townsend mentions as being evident in some of his feldspar, could be removed in this manner as also could iron sulphide.

For the benefit of those unfamiliar with concentrating tables a simple description would be of interest.

The wet tables are about 15 ft. long and 6 ft. wide. They are slightly inclined to one corner and receive a rapid vibratory motion in the direction of their length. The feed is at the high corner and due to the vibration the product is spread out over the surface. The heavier materials sink into grooves arranged lengthwise on the table and are discharged at the low end. The lighter materials overflow the grooves and are discharged at the side.

The dry concentrating tables operate on the same principle, except that the feed is made to flow by the introduction of low pressure air through a screen on the top of the table. Another device for dry concentration is the plumb pneumatic jig. This is a small machine 3½ inches wide and 24 to 36 inches long. The feed rests on a screen in a bed about 2 inches deep and this bed is caused to vibrate by pulsations of air from below. The heavier materials sink to the bottom and the lighter overflow at the top. The heavier particles are continuously removed by a simple device on the machine. The writer has had no opportunity of observing these dry machines in action but is of the opinion that they would perform their work satisfactorily and readily remove heavy impurities from feldspar.

REPLY TO MR. MOORE BY W. H. LANDERS:—Mr. C. R. Moore has made some rather interesting comments on certain feldspar grinding problems. Most feldspar as received by the miller, even if wet by recent rains, does not contain over 2% of moisture. It is necessary to dry this to less than 1% before dry grinding, or more properly speaking, dry pulverizing can be satisfactorily carried on. This can be done mechanically in the case of large tonnages, or under drying sheds, where a comparatively small tonnage is handled daily. One very interesting situation has been noticed recently and that is that the so-called dry ground feldspar seldom contains less than 1% of moisture, and may reach 3% without its dampness being apparent. This added moisture is unquestionably obtained from the humidity of the atmosphere, as it is certain that it comes out of the mechanical dryer with far less than 1%, and yet when sampled in the car 24 hours after milling, has apparently taken up considerable moisture from some source.

A sample thoroughly dried and left on a scale pan over night, shows very definitely increased weight within 12 hours, particularly if the day happens to have been a very humid one. Actual practice demonstrates that from a milling standpoint, wet grinding is in every way preferable to dry grinding, when the former operation is thoroughly understood. Recent tests on a large conical mill gave an average monthly performance of 2.6 tons per hour when grinding dry, from 1-inch size to 50% through 150-mesh, and when grinding wet, a tonnage of over 6 tons per hour was reached without discovering what the ultimate capacity of this particular mill was. This difference would be even greater on the tube mills. It

is a very simple matter to reduce the moisture from wet mill pulp to less than 20% on the very fine sizes, but from that point on, drying is necessary; it can be satisfactorily and continuously performed at a very reasonable cost, and without danger of adding iron to the finished product.

The peculiar nature of the feldspar filter cake, however, very definitely limits the type of dryer to be employed. Wet grinding can best be employed, however, when it is desired to turn out a comparatively large tonnage, to make extremely fine sizes, or to purify the feldspar in process. As Mr. Moore states, the feldspar pulp can be used by the manufacturer in the form of slurry, without previous drying; that is what the British practice.

A method of storing wet pulp without constant agitation is possible and is practically used.

With respect to purification, quartz seems to be the only thing not now being substantially removed where the wet process is used.

By C. M. Franzheim:—I have read with a great deal of interest the various colloquiums and discussions issued this year on the subject of feldspar, and feel as though a great deal of good has been done in this discussion in bringing out the various weaknesses and strong points of the development of feldspar. By which I mean, the proper development of feldspar.

The problem of the preparation of the various grades of flints for the ceramic industry is fundamentally a grinding problem, but the preparation of feldspar for the ceramic industry is fundamentally a mining problem.

In the minds of ninety per cent of the feldspar-using trades they fail to recognize this fundamental fact.

The bulk of the cost of flint of the ordinary kind is in grinding. The bulk of the cost of most all feldspars is in labor, in the selection of the rock and the mining of it. The cost of grinding feldspar is, therefore, much smaller than the cost of the labor of the mining. Flint deposits and feldspar deposits have entirely different characteristics as a general rule.

Of course, were there to be found a feldspar deposit of any large size with practically pure feldspar, then it would be possible, not only to sell this feldspar almost as cheaply as flint, but that particular mine would then be a grinding problem and not a mining problem. Unfortunately, there are no such feldspar mines anywhere, hence all feldspar mines today are in the category of mining problems, and will remain so until such a large pure deposit of feldspar is found.

I have noted also in some of the recent discussions, the suggested advisability of feldspar specifications. We would welcome this, but it would be impossible for any set of specifications to be drawn up to be of any real practical or commercial value. Of course, it is possible to draw up a set

of specifications to suit all cases, but it would have to be so broad in its scope as to be practically valueless in the majority of individual requirements.

The reason why such a specification would not be practical, or have possible value is because of the different characteristics of the feldspar deposits located in the different fields. Unless the specification was general enough to take in all possible feldspar it would then be preferential, and preferential specifications could not possibly be of commercial value to the trades as a whole.

Canadian feldspars have some very fine characteristics for certain trades. Maine feldspars have very fine characteristics for certain trades, and other feldspars all have their own characteristics and may, or may not, be adapted to certain businesses, as the case may be.

The fact that a particular feldspar has a higher potash content, or a higher alkali content than some other feldspar does not mean that feldspar is far more valuable. It may be quite the reverse. It is the proper balance of the feldspar which counts and makes it valuable. Because of the high alkali contents of any feldspar the alumina content has such a bearing in helping maintain the balance that all the good of high potash may be lost by high alumina. Or, all the good of high potash and properly balanced alumina may be lost by black mica, high quartz or poor color. Feldspar mines which are operating today on a commercial basis may be inactive within the next ten years because even mines change or exhaust themselves. How then can specifications be drawn up for feldspar in a general way when specifications do not take into consideration, or cannot possibly do so, the very principal element of feldspar, namely its uniformity and constancy from year to year. This is the most difficult problem of feldspar producers in conjunction with careful mining. A feldspar which is properly balanced, and will only run uniform for a period of two or three months, although conforming to all specifications, is not a proper feldspar on a commercial basis, and the great value of feldspar is its uniformity from car to car, from month to month, and year to year, and any plant can become accustomed to any feldspar, regardless of specifications, provided that feldspar comes uniform from year to year. It is just as wrong for a feldspar producer to suddenly ship a pottery a car or two of excellent feldspar, much better than the last two cars, than it is to ship them feldspar which would be inferior to the last two cars, and greater loss on any pottery can be entailed by suddenly improving the quality of the feldspar without notice to them than a sudden lessening of the quality. If feldspar cannot be produced not only uniformly from month to month, but from year to year, then that feldspar is not a commercial grade. After all the uniformity of feldspar from year to year determines its real value, regardless of black speck, of potash content and of any other feature,

even price. Of course, all those items have some bearing, but in the end uniformity of the product is seventy per cent of the battle.

Naturally a feldspar producer does not want any more black speck, due to black mica or other foreign substance, in the feldspar than does the user, but he is required to accept the deposits as laid down by Providence, and there is not a commercial feldspar mine anywhere which does not contain these foreign substances. When one buys oranges he gets seeds, although it is possible to buy oranges without seeds. But as a rule, the oranges without seeds do not have the juice, and it is the juice that we are after. Is it not cheaper and best to buy oranges with the seeds and remove them, thus securing the greatest volume of juice? Of course, there are sometimes exceptions, and so are there exceptions with feldspar, but feldspar specifications which say there shall be no black speck are of no value because there is not one feldspar producer who can honestly fulfill same. And usually these exceptions are not feldspar offerings on a standard commercial basis.

REPLY TO MR. FRANZHEIM BY W. H. LANDERS:—Mr. C. M. Franzheim's claim that the preparation of feldspar for the ceramic industry, is fundamentally a mining problem is quite justified, but there is no reason why the preparation of flints should not also be so classified. The greater proportion of flint used, and the consequent demand for a lower price has no doubt had some influence in getting the consumer to accept such flint as is offered without subjecting it to the critical discrimination with which he judges feldspar or other materials which appear on the surface of the finished ware.

The various clays appear as the result of a mining problem which the clay producer will insist is no less important than that of the feldspar miner.

The truth is that none of the rock products entering into the ceramic industry occur in such a pure state and in such large bodies that they have only to be considered from the "preparation for market" standpoint. Feldspar, as stated before, appearing as a finished material, and therefore subject to the scrutiny of the consumer, has come in for an amount of unjust criticism, and too much has been blamed on the feldspar, when the guilt should be shared by the other elements present.

It must not be overlooked that in England, a considerable quantity of material doing similar duty to our spar, is nothing more nor less than granite ground in water, and delivered wet in tank wagons to the potters and other users They get away with it, and succeed in turning out some very high grade porcelain ware.

They seem to be somewhat more critical of their clays. In this country, up to the present time, we have been skimming the cream so to speak, from extraordinarily pure and favorably located feldspar deposits, and it is

only as these are being mined out, that dissatisfaction has appeared in the ranks of the users of feldspar.

When it is desired to make any high grade finished product one of the prime requisites is to start with the best raw material obtainable.

The amount of impurities present in the crude, while being substantially reduced by subsequent operations, can seldom be completely eliminated.

It remains therefore, to establish as many standard specifications as possible, to enable both the miner and grinder of feldspar, to set a mark to shoot at; without these there can be no real advance towards improving or making more uniform, the quality of spar turned out by the grinders. Certain natural characteristics such as high or low fusing points, amount of alumina present or the ratios of the two alkalis, will always make feldspars from certain districts differ from those from other districts, and the time will probably never be reached, when the manufacturer can buy feldspar indiscriminately, with as little concern as he now buys gasoline to run his automobile. He may expect and demand uniform results from feldspars produced in each district. This will come more from improved milling and purification methods, than it will from the unsatisfactory and costly selective mining methods now so generally practiced.

When it is realized that most of the objectionable impurities, with the exception of quartz, are present in only small fractions of a per cent, even in the granites or very low grade spars the question of milling or the preparation of a satisfactory product for market, cannot help but become of prime importance. So-called second grade feldspars can be made into a very satisfactory, high grade product by methods now available, but it will be necessary to have certain standards established before these improvements can be generally adopted. Mr. Franzheim stresses the importance of uniformity, but he must realize that there can be little hope of uniformity, so long as the present milling practices are indulged in. Old customs die hard, and competition is their most ruthless destroyer.

GLASS INDUSTRY IN INDIA[1]

By G. P. Ogale

The word "kanch" (glass) is found mentioned very often in old Sanskrit literature during the last two thousand years, signifying the knowledge of glass-making among the ancient Hindus, although adequate records are not available as regards its manufacture, nor have ancient samples and relics been systematically preserved. Glazed tiles were used for flooring and wall decorations even in the twelfth and thirteenth centuries and samples of this kind of work can be seen on buildings of that period. The manufacture of glass bangles (bracelets) and beads was practiced in very ancient

[1] Received March 10, 1921.

times and the authentic existence of these can be traced as far back as the last six hundred years. These were made in the province of Agra and Oudh in the north, in the province of Gujrat and in a few places in the south.

The glass was melted in small clay pots on wood or charcoal fire, and the bangles were made by gathering a small quantity of glass at the end of a small steel rod, and turning the rod by hand and expanding the soft bead of glass into a ring, which was afterwards placed on a clay cone and further expanded to proper size. Even today the demand for these bangles is met by a system of indigenous household industry. Every Indian woman wears at least two or three bangles round her wrist and these form a necessary ornament of a married woman.

There are at present many factories in India on modern scale, turning out hundreds of tons of colored glass in order to supply the demand of the bangle makers, who buy it in the form of cakes or blocks and remelt it in their small furnaces and make bangles. Formerly these people made their own glass, but now prefer to buy it from factories. The household industry also produces small vials, lamps and perfume bottles, but these are very inferior in quality.

Glass factories on modern scale date back only to the last fifty years or so. They were organized with Indian capital but were generally managed by Austrian or German experts. The history of these factories has been one of continuous struggle against various difficulties. The greatest difficulty was to get proper technical help. The training of local labor also had to be arranged for. The so-called experts were in some cases mere adventurers, who worked only during the construction of the factory and bade good-bye even before starting work. Another man who was recruited in his place probably condemned the work done by his predecessors and construction had to be substantially altered.

The experts were not generally willing to train Indian workmen, and in some cases, where they were willing, the proprietors of the factory would not stand the expense of training the labor and waiting until it started paying back. The people who put in their money invested it more from patriotic enthusiasm than from a purely business motive. The lack of technical knowledge on the part of the promoters was a standing obstacle in the progress of the factories and the industry in general.

Then again, the high temperature during the summer months caused many of the European experts to quit their jobs and no adequate arrangement of cooling by artificial means was adopted in any factory. This caused slackness even among the Indian workmen and plants had to be shut down during the hot season.

If Indian works could adopt the air circulation system as is used in this country, the factories could be worked all the year round.

One great cause of the failure in all these factories was the want of government protection or direct help, especially in the beginning, against outside competition. India, owing to her peculiar political situation, has been unfortunately a dumping ground for foreign manufactured goods and unless a system or protective tariff is devised to safeguard industries within her own borders, she will continue to be the happy hunting ground of foreign adventurers to her own detriment.

To fight certain of the causes, the public made an attempt in a new direction. They raised a fund called a "penny fund" and opened a glass school at Talegaon near Bombay about fifteen years ago. The management of this school was placed in the hands of Mr. Ishwardas Varshnei, who had gained his experience in the United States and in Japan. He started with a small direct-fired pot-furnace with the help of Japanese blowers, and took a few Hindu boys for training as blowers. In a few years a good number of hands were trained as blowers, and the plan worked quite well—so much so that the boys are now running the school factory on a profitable basis, while Mr. Varshnei is running three or four factories in the Punjab. He is now trying to put his factories on a most up-to-date scale and is soon to add a window-glass plant to his list. A dozen other factories have been started by the students of the Talegaon school, and are making a steady progress.

The goods turned out at present in the Indian factories are lamp chimneys and globes, tumblers, pressed-ware and bottles. No doubt, the factories working at present are on a small scale and do not supply even a tenth of the demand. Yet they have inspired confidence among the capitalists and big plants are soon to be expected on most modern lines.

Though India abounds in raw materials for the glass industry, these have not as yet been properly investigated. There are good sand deposits in the north, in Gujrat and in the Mysore and Madras presidency. Besides there is plenty of soft sandstone and quartz distributed all over. There is a suitable supply of limestone also well distributed. India produces the largest quantities of manganese in the world. Nitre is produced in the United Provinces. Soda, from the Reh deposits and also from the lakes in Rajputana and Central Provinces is awaiting investigation. At present English soda is largely used. The fuel used is bituminous coal from Bengal and the Central Provinces. Wood is used in two or three factories.

India imports about eight million dollars worth of glass every year from various countries such as England, France, Belgium, Germany, Austria, Japan and the United States. Before the war Austria Hungary ranked first on account of its sales of glass bangles and also took a prominent part in the trade of lamp chimneys. Among exports from Germany were bottles, lamp glasses, and false pearls. The United Kingdom monopolized

the trade in soda bottles and also exported in large quantities bottles and vials, sheet and plate glass and tableware.

The supplies from Belgium consisted of lamp chimneys, pressed tumblers and window-glass.

Japan today holds a very prominent position in her exports of glass to India and has generally taken the place of Germany, Austria and Belgium during war time and is trying to maintain her predominance in the market. The quality of Japanese goods is improving remarkably and Japan has her own methods of underselling.

Owing to the more extended use of glass, the imports of glass in India are constantly increasing in spite of the local manufacture.

OGALE GLASS WORKS, LTD.
OGALWADI OUNDH STATE
DIST. STARA, INDIA

DISCUSSION[1] ON "THE PRODUCTS OF THE CALCINATION OF FLINT AND CHALCEDONY"[2]

BY C. N. FENNER:—In the September number of this *Journal* Washburn and Navias present the results of their study of flint and chalcedony. I should like to offer some discussion of certain parts of their conclusions. These parts are embraced in the following summary of their views (page 581): "(1) Flint and chalcedony consist of colloidal quartz. In the purer forms of chalcedony the colloid is of the gel type and the individual colloidal particles are microscopic or sub-microscopic in size. Fenner found that when chalcedony was heated in contact with a flux at 800°, 'quartz' and tridymite were produced. The 'quartz,' *i. e.*, macrocrystalline quartz, is evidently the result of the recrystallization of the colloidal crystals, and quartz is, of course, the stable form at this temperature. The simultaneous appearance of the metastable tridymite under such conditions is a common phenomenon..... (4) Fenner made a thermal analysis of raw chalcedony over the quartz α-β inversion temperature and failed to find any heat effect indicating an inversion at this temperature. It was largely because of this negative result that he concluded that chalcedony could not be classified as quartz. Now it is altogether probable that both the inversion temperature and the heat of inversion of a quartz crystal vary markedly with the size of the crystal, for crystals of colloidal dimensions. Consequently, according to our theory of the nature of raw chalcedony, we might expect that the quartz inversion would be spread over a considerable range of temperature owing to the varying sizes of particles present, and this inversion might, therefore, easily fail to be detected by the method of thermal analysis."

[1] Recd. Sept. 16, 1922.

[2] Washburn and Navias, *Jour. Amer. Ceram. Soc.*, **5**, 565(1922).

In this explanation the idea of colloidal quartz plays an important part; in fact, the whole theory may be said to rest upon it. By this term I understand that what is meant is silica particles in each of which the atoms are oriented according to the crystal pattern of quartz, but of such minute dimensions individually that surface forces play an important rôle with regard to their environment, and their free energy is thereby considerably increased.

Now I have no objection to offer on theoretical grounds to the idea that quartz particles might be reduced mechanically to such an extreme state of fineness, or might under some circumstances be formed that way in nature, but I think there might be room for question as to whether the natural deposition of quartz from solution in such minute particles under the conditions that give rise to chalcedony, would be probable. This phase of the question, however, is one on which I would bear very lightly because definite data are lacking; but there is another on which one may speak with more confidence. Chalcedony is not a satisfactory material for microscopic study, but that is largely due to its fibers intermeshing in such a way that aggregate optical effects are likely to be obtained. The individual fibers are rather small units, but usually large enough so that the optical character of their elongation may be obtained, and I should suppose that there is a world of difference between units of this size and those approaching molecular dimensions, where surface forces would be an important factor.

The explanation of Washburn and Navias would require that the grains of their colloidal quartz should be so infinitesimal that its free energy would be greater than that of tridymite, for evidently that is the basis of their explanation of the appearance of tridymite in those experiments of mine in which chalcedony was heated with sodium tungstate at 800°. They say that "the appearance of the metastable tridymite under such conditions is a common phenomenon." I should be glad to have examples of this given, as I am not familiar with anything that seems closely comparable.

The foregoing remarks indicate the points of their theory that seem to me not entirely convincing. On the other hand, the evidence supplied by the X-ray crystal spectra that they reproduce seems to show quite definitely that the material they worked with contained quartz. There are two possibilities that occur to me by which the apparently conflicting evidence might be harmonized.[1] One of these is implied in the paper to which Washburn and Navias have made reference.[2] There I suggest that chalcedony may be a mixture of quartz and some other form of silica

[1] There is nothing essentially new in either of these suggestions.

[2] C. N. Fenner, "The Stability Relations of the Silica Minerals," *Am. J. Sci.*, 36, p. 380.

(presumably amorphous silica). The presence of the amorphous silica would account for the formation of tridymite at 800°, and would tend to blur the evidence of the α-β inversion so that it might not be recognizable. The objection I have felt to this explanation is that it implies the presence of such an amount of amorphous silica that, as I thought, it should have been recognizable microscopically, but I am open to conviction on this point.[1]

The second possibility is that one sample of chalcedony may differ from another in its constitution, and that the superficial resemblance is misleading. In that case different investigators may have worked on different substances. Some basis for this idea may be supposed to be found in the existence of the various similar substances known as quartzine, lutecine, and lussatite which have been described.[2]

The essence of the foregoing may be stated in a few words. Washburn and Navias have presented evidence to show that some chalcedony at least contains crystalline quartz, and this is a distinct contribution to our knowledge of the subject, but the theory of colloidal crystals that they offer in order to bring this into harmony with apparently contradictory results obtained by others does not seem altogether satisfactory, and further evidence is desirable before the problem can be considered settled.

GEOPHYSICAL LABORATORY
CARNEGIE INSTITUTION OF WASHINGTON
SEPT. 12, 1922

REPLY BY E. W. WASHBURN:[3]—Dr. Fenner's viewpoint regarding the constitution of chalcedony is not essentially different from the one proposed by us. He suggests that the chalcedony, in addition to containing very small quartz crystals, also may contain amorphous silica. According to our theory of the colloidal constitution of the mineral, it would be formed by the deposition of colloidal quartz made up of exceedingly small crystals of varying sizes. The smaller of these crystals would probably be somewhat ill-formed and would shade off gradually into a material in which the crystalline form was so ill-defined that it might be more properly called amorphous, so that we would have all gradations from some particles practically lacking in crystalline form up through ill-formed crystalline particles to larger and more perfectly formed quartz crystals.

Our remark in citing the appearance of tridymite as an example of a common phenomenon referred merely to the well-known frequent appearance of a metastable phase from a solution saturated with respect to a more stable phase. A solution saturated with respect to quartz, such as

[1] With regard to the possible existence of such a mixture, see H. Leitmeier in article "Chalcedon" in Doelter's Handbuch der Chemie, Bd. 2, erst Hälfte, page 166.

[2] H. Leitmeier, *loc. cit.*, page 165.

[3] Received Sept. 27, 1922.

the one obtained in Dr. Fenner's experiment at 800°, might also be saturated with respect to tridymite. As Dr. Fenner points out, this would of course, necessitate that some of the colloidal particles of the chalcedony would have to be small enough so that they would have a greater free energy than macroscopic tridymite crystals.

As suggested in our paper, it would be interesting to determine the volume change of chalcedony over the quartz α-β inversion temperature. This might give some indication of the amount of crystalline quartz present in the mineral, although here again the volume change on inversion might be expected to vary somewhat with the size of the crystal. For such an experiment it would be necessary first to dry the chalcedony in vacuo at a temperature below that at which inversion could occur.

DISCUSSION ON "NOTES ON SHIVERING OF TERRA COTTA"[1]

E. C. HILL:—I should like to ask Mr. Carruthers, whether he found increased shivering on aging or weathering of these trials. It is well established that crazing increases on weathering, but I have not noticed any further development of shivering on weathering.

In a series of trials I made, using various clays and grog, shivering developed on one trial of a Georgia kaolin body. The same series included a very sandy clay, which developed crazing. From Mr. Carruthers' results, we should expect the sandy clay to develop shivering instead of crazing. The shivering on the Georgia kaolin body might be a form of "peeling," however, since this body is very porous.

MR. CARRUTHERS:—Our experience with shivering has led us to believe that its tendency is always present under certain conditions. Lines of strain will show in ware taken hot from the kiln which will open up later. These lines show where shivering has taken place in the kiln. We have had a number of shivered samples out on the roof of the plant for four years and on which the shivering has not increased.

MR. HOTTINGER:—I wish to call to your attention the fact that in the use of fine silica, the finer you grind the silica the more of it your glaze will take. That is shown very clearly in Mr. Carruther's exhibit. Shivering will be found with the fine silica while with the same content of silica, but coarse, the tendency to shiver will be less.

You might say that the fine silica dissolved by the glaze changes its coefficient causing shivering, whereas with the Georgia clay which is free from silica you have just the opposite. That is, the glaze dissolves clay substance very slowly and if the glaze was not absolutely fitted to the body, the body being very weak, you would be liable to run into shivering. I think that is one explanation, possibly, of the point that you brought out.

[1] J. L. Carruthers, *Jour. Amer. Ceram. Soc.*, **5**, 518 (1922).

MR. C. W. HILL:—Mr. Carruthers' paper contains many interesting points which doubtless will be of value to others in suggesting the direction in which to go in correcting trouble from shivering. Since the bodies and glazes used by different manufacturers differ widely in properties it is probably unsafe to generalize on the results obtained with specific bodies and a single glaze. Mr. Carruthers very wisely qualifies many statements as referring to his particular conditions.

It is perhaps indicative of the present state of knowledge and methods that this paper like many others deals largely in qualitative tests. It would seem desirable for all of us to attempt to work down to fundamentals. There is, of course, a physical basis for the phenomena observed. Shivering is usually attributed to difference in thermal expansion of the body and the glaze ("poor fit"). Assuming this to be the case it would make such investigations more valuable from a general standpoint if the changes in composition were tied up with determined changes in physical properties such as the coefficient of expansion. With the Bureau of Standards equipped to handle such tests it would seem a comparatively simple matter to secure such data. The science of our industry can be advanced more rapidly by more rigorous methods in our research and as a Society we should, I think, urge upon all contributors to our Journals the necessity for more quantitative physical data along with the qualitative practical tests.

Mr. Carruthers' data would doubtless be of more value to others if he had included the results of common tests generally in use on the clays and bodies (*e. g., clays*—dry and burned shrinkage, porosity, mechanical analysis, *bodies*—absorption, density, coefficient of expansion).

It is doubtful whether it is correct to include under shivering the result of incorrect glaze fit and that of poor tenacity resulting from soluble salts. In many cases it is possible to differentiate between the two effects by observation, one being termed shivering and the other glaze peeling.

Mr. Carruthers' figures on the effect of addition of soluble salts are difficult of interpretation since the amount and kind of soluble salts already in the body are not given. The total amount of salt required to give peeling would be valuable information.

The use of felsite commercially is very interesting from a practical standpoint as well as from its connection with the work of others on fluxes in terra cotta bodies. It is unfortunate again that Mr. Carruthers has been content to let his investigation rest with the qualitative results. Mr. Carruthers questions whether the felsite has an effect on expansion but does not test the point. Obviously if our usual explanation of shivering is correct it must change the expansion. This should be determined as it is the most valuable point in the whole matter. Having determined that the expansion is changed by the flux it is also very important to know how this is effected. From the miscroscopic examination of Body 6

(Table V) the indication is that the felsite does not attack the free silica but forms a bond around the quartz grains. The effect of felsite on other properties than expansion should also be stated such as green and burned shrinkage, density and porosity.

Mr. Carruthers deals with a subject of general interest and touches on many important points. Anyone in commercial work can understand the difficulties which prevent the complete investigation of a subject and which often result in the reporting of an investigation more as a specific factory problem than as a piece of fundamental research permitting general application. It is to be hoped that as time permits Mr. Carruthers will fill out the work with the tests and data indicated and thus make a noteworthy contribution to the literature of our industry.

MR. CARRUTHERS:—As Mr. Hottinger and Mr. C. W. Hill have both stated, shivering is purely a local trouble, due to the body and glaze not being properly fitted together. However, we have had the body and glazes properly fitted and then almost over night, shivering would occur This we have traced to the action of excess fine silica occurring in the clay or grog. This change in the body composition will take place without any physical difference being noted in the raw body.

For a number of years, the method of overcoming the trouble, was to fit the glazes to the changed body. Now, we find it more practical to fit the body to the glazes. This is accomplished by the use of a flux such as felsite. It has made the body more safe, *i. e.*, variations in the amount of silica present in the clay or grog are taken care of and shivering troubles eliminated.

DISCUSSION[1] ON "DATA ON VISCOSITY OF INDIANA CLAY SLIP WITH ELECTROLYTES IN REGARD TO THE CASTING OF TERRA COTTA"[2]

BY R. L. CLARE:—Casting of terra cotta appears to be a logical method of forming small pieces of intricate, or highly ornamented shapes. This includes balusters, rosettes, small gargoyles, small brackets and other small ornamental pieces. Pieces, such as these, do not necessarily have to have a thick wall and their shape lends itself to casting. Pieces such as these also are difficult to press without making them nearly solid, and consequently they are much more liable to spalling, cracking, etc. The splitting of balusters where they are joined would also be eliminated by casting.

Large material, such as ashlar pieces, or other running pieces requiring partitions and thicker surfaces, do not lend themselves quite so readily to

[1] Received Sept. 21, 1922.

[2] H. E. Davis, *Jour. Amer. Ceram. Soc.*, **5**, 702 (1922).

casting, and the question of speed of production, cost of moulds, etc., makes it questionable as to its economic possibility.

The difficulties we encountered in casting were that the changes in the clay made it necessary for us to change the proportion of electrolyte constantly, and that a proper electrolyte for the clay one month was not satisfactory the next. This we attributed to a difference in the soluble salts in the clays received. We used both sodium carbonate and sodium silicate and found that a mixture of the two gave the best results.

DISCUSSION ON "AN ACCOUNT OF AN INVESTIGATION OF SOME GEORGIA CLAYS AND BAUXITES"[1]

By W. C. Woodall:—May I say a word of sincere appreciation of the enterprise and friendly interest of *The Journal of the American Ceramic Society* in publishing in its September issue the clear and comprehensive article by Messrs. Gilmore and Fessler relative to the tests of Georgia clays now being made at the Ceramic Station at Columbus, Ohio. The article bears evidence of thorough investigation of this subject, and the publicity thus given this phase of industry in Georgia will beyond doubt hasten the development of the clay and bauxite deposits in the state.

Vast as are the clay deposits of Georgia, the ignorance that has prevailed regarding the ceramic possibilities of this tremendous mass of material, its availability as pottery material and as refractories, has been almost as vast. Today, the first thorough investigation of this material, the first complete, scientific test, is being made. It is interesting to note that this important step was taken at the instance of a progressive railway company which believes in intelligent coöperative effort in the development of the country it serves.

The Central of Georgia Railway, having the largest Georgia mileage of any railroad system has keen realization of the responsibility that this entails and has taken active part in state development work.

Under these conditions, an authoritative investigation of one of the state's greatest natural resources, and its possibilities for refinement and utilization is peculiarly timely. It is the earnest desire of Georgians to witness the development to utilize to the fullest extent the resources of their state by capital from abroad. With the middle belt of the state practically a clay bed, a source of tremendous wealth—an industry that will provide employment for many thousands, that will give capital to another safe and profitable field of development—is indicated. The clay industry should become one of the chief enterprises of Georgia.

The Industrial Index
Columbus, Ga

[1] Gilmore and Fessler, *Jour. Amer. Ceram. Soc.* (*Bull*)., **5**, 193 (1922).

DISCUSSION ON "WET PROCESS ENAMELS FOR CAST IRON"[1]

By J. E. Hansen:[2]—This paper is an especially valuable contribution both to the literature and to the enameling industry, not only because of the fact that it is the first contribution of its kind, but because of the extensive scope of the investigation reported. However, to justify the excellent results obtained by other wet process enamels already in use on cast iron, and not to lead to misapprehensions on the part of future investigators, it should be borne in mind that some of the conclusions reached are true only on enamels of the particular type under discussion and may not apply to all types; for instance, the limit as given for sodium oxide in a sintered ground coat may safely be exceeded in a ground coat of the melted type. Also it is known that certain types of a melted ground coat, with suitable mill additions, are highly successful and may give even greater strength and adherence than those of the sintered type.

The observations and experience of the writer check in general the statements of the authors of this paper. It has clearly been the experience of the writer that the fusion point of ground coats and cover enamels should bear a close relation to each other, and that, if the composition is correct, the cover enamel can be burned at the same temperature or even a slightly higher temperature than the ground coat.

The writer believes that many cases of pinholing in cover enamels can be traced to the lack of such a close relationship in the fusion points of the respective coats and to overburning of the cover enamel.

The writer does not, however, agree with the authors, in their statement that the crawling of high boric oxide enamels is due to the higher viscosity imparted by an excessive amount of that oxide, but believes rather that it is due to the dissolved salts of boric acid which, crystallized from the aqueous suspension of the frit, give up their water of crystallization as the enamel is fired, and by their swelling cause crawling.

The crawling of enamels high in cryolite may possibly be explained by the high viscosity and high surface tension of enamels rich in aluminum compounds, in this case aluminum fluoride. The same effect can be developed in an enamel to which a large amount of aluminum oxide or hydrate is added.

The writer believes that while the enamel composition is undoubtedly of greatest importance, almost as significant factors in the successful enameling of cast iron by the wet process are the manipulation of the enamel and the nature of the cast iron to be enameled.

By W. C. Lindemann:[3]—In checking over the work done by Mr. R. R.

[1] Danielson and Reinecker, *Jour. Amer. Ceram. Soc.*, **5**, 647 (1922).

[2] Sept. 8, 1922.

[3] Recd. September 16, 1922.

Danielson on wet cast iron enamel, all such enamels both in ground coat and cover coat that seem practicable, were tried out on a commercial basis in our enameling plant. The enamels were smelted in commercial batches and the ground coats were fritted, the batches for cover coat being 450 lbs. to a smelt, and the ground coat batches fritted were 125 lbs. to a batch. They were then milled in the usual mill batches varying from 100 to 250 lbs. to a mill. Mill additions were made as shown in the formulas submitted by Mr. Danielson.

The results in general checked the results shown in the laboratory. However, in using the wet cast iron enamel, the actual operation of coating and burning a piece, is of such importance that absolute information cannot be given on any trials until all the operators have been accustomed to the use of any one particular enamel. In this respect, the checking up of one batch of smelted enamel is hardly sufficient to give a definite check on laboratory results although if the results are very bad, one batch is sufficient to show whether the enamel is commercially practicable or not. When the enamel is nearly right, small defects as may appear cannot be attributed directly either to the enamel or the operation, and indefinite results are obtained.

However, in the trials such enamels as proved very bad were immediately dropped from consideration and such other enamels as proved fair were retried on further smelts until a reasonably accurate decision could be given on the same.

The results obtained do not entirely check with the summary given by Mr. Danielson. The ground coats that gave the best results were as follow in the order named: Rg 7, Rg1 and Rg 26. Ground coats Rg 17, 25 and 18 as mentioned by Mr. Danielson were not practicable on continuous use causing various defects in the final enamel which could not be overcome. On the other hand, Mr. Danielson does not mention Rg 7, which seemed to give uniformly good results on all trials.

Regarding the cover coat, the results show that R1 seemed to be the best for general purposes with R14 and R11 as reasonably good enamels. However, R 28 and R18 as mentioned did not give satisfactory results, R 28 not having sufficient covering capacity and R18 being the same way. Both R 28 and R18 if covered heavily, would cause crawling to such an extent that the pieces would be unusable.

There is a very marked difference in using certain cover coats for certain ground coats and this is especially noticeable on wet cast iron work.

The ground coats and cover coats given above, all seem to work reasonably well together using any one of the ground coats with any one of the cover coats, but the best combination seemed to be as a final check-up, the use of Rg 7 as a ground coat with R1 as a finish coat. However, precaution was necessary on the use of these enamels since the Rg 7 was

rather sensitive on firing and if over-burnt caused cracking in the finish enamel and when under-fired, caused blistering. However, if this ground coat was burnt properly, good results could be uniformly expected. In addition, when using Rg 7 as a ground coat, there were less black spots appeared in the white or finish coat than on any other enamels tried in the entire series. This is an important item since there are very few enamels in wet cast iron work when using a white finish coat where black spots are not noticeable.

By M. E. Manson:—Probably every enameler who reads Messrs. Danielson and Reinecker's paper will find that at certain points their findings are radically different from his own experience. Near the end of the paper, the authors state:

> The fact that cryolite had vastly different effects in the two different types of basic enamels, shows rather definitely that a broad statement cannot be made as to its effect in different types of composition.

I believe that this statement could be enlarged to include not only cryolite, but every ingredient of the enamel.

To the sanitary ware manufacturer, using the dry process of enameling, wet enameling is apt to be of merely academic interest. Nevertheless he has many small pieces, which it would be entirely possible to enamel by the wet process at a great financial saving.

At our plant here we have done a small amount of experimental work on this subject, which has in some features borne out Mr. Danielson's work and in others has not. We found that the degree of smelting the ground coat was of great importance. I even know of one formula, which when mixed raw in a mill, gave very good results. When sintered, and ground, and covered with the same cover coat, it blistered badly. With the particular ground coat which was the basis of most of our experiments, we found that the addition of 15 to 20% of clay in the mill gave best results. Our greatest trouble with this series was blistering of the cover coat. By adding 20% of clay in the mill, and softening the frit accordingly, we did away with the blisters, but the cover enamel was still full of what Danielson calls "incipient pinholes." They look like skin pores, and are present in nearly every piece of wet enameled cast iron I have ever seen.

The further modification of this formula, by reducing lead oxide from 8 to 3% and raising borax proportionately, gave us a successful wet enamel. Test pieces made from this were uniformly good, with very few pores. A hundred pound batch, used on regular factory pieces was fairly successful, but required very careful burning. This substitution of borax for lead oxide had exactly the opposite effect from that observed by Mr. Danielson.

There are many factors affecting a wet enamel besides the enamel composition. A ground coat which will give good results when burned at 1500 degrees will be a failure at 1700 degrees. If the pieces to be enameled will not warp at 1700 degrees an enamel should be developed which will work at that temperature, for production will be higher.

The composition of the iron is an important factor. Formulas which give good results at one foundry, will frequently give miserable results on iron from another foundry.

Still another factor is the thickness of the ground coat. Our ground coat for dry enameling is applied in a very thin coat. I have seen wet enamelers apply what they considered a thin ground, which was nearly twice as thick as ours. It sometimes happens that a ground coat can be made to give much better results if a thinner coating is used.

The above observations are from the small amount of work done here on this subject. As I said before, a good wet enamel was not of such vital interest to us. The most surprising thing in our whole series of experiments was the result we obtained with our own dry process enamel. We used our regular ground coat. We took our regular white coat, ground it with water, 6% clay, and 8% tin oxide, and used it as a cover, and this gave us the best results we have had. This may be only an exceptional case. Nevertheless I would like to know what results could be obtained by the other sanitary ware enamelers, using their composition as a wet enamel.

This whole subject, in spite of the rapid progress it has made is still in its infancy, with much work remaining to be done. Mr. Danielson's excellent paper, however, goes a long way toward the goal of a good wet enamel for cast iron.

REPLY TO MR. HANSEN BY MR. DANIELSON:—While we have recommended the "sintering" of all ground coats in this investigation, this is not to be interpreted as meaning that all compositions are of the usual sintered type, that is having a dull refractory finish when fired on the casting. The majority of the ground coats can be fired to a semi-glassy finish. However, we have found that the sintering method results in ground coats possessing more satisfactory adherence to the castings. Almost invariably adherence has been improved by the undersmelting of the ground coat.

We are inclined to disagree with Mr. Hansen that the crawling of the enamels high in boric oxide is due to the dissolved salts of boric acid rather than to the viscosity imparted by excess boric oxide. Enamels of this type are very viscous even in the smelting and the same phenomenon has been noted in enamels for sheet steel. While the soluble salts may tend to cause cracking in extreme cases, we cannot believe that this action alone

would cause crawling on enamels fired as slowly as the enamels applied on castings.

REPLY TO MR. MANSON BY MR. DANIELSON:—The various factors aside from enamel composition mentioned by Mr. Manson undoubtedly have an important bearing on the results to be obtained with enamels of the wet process type, but the same conditions are encountered in practically any type of enameling. As a result of our experiments we question, however, whether enamels maturing at 1700°F are practicable for wet process enameling on cast iron. At this temperature we believe there would be a tendency for the surface of the enamel to gloss over in the early stages of the firing, tending to entrap gases held in the castings, with blistering of the enamel as a result.

While certain dry process enamels do give good results when used by the wet process, as stated by Mr. Manson, our results in the application of dry process enamels to this method clearly show that this is not true in all cases and that very unsatisfactory results can be expected with certain other types.

REPLY TO MR. LINDEMANN BY MR. DANIELSON:—Mr. Lindemann's discussion is of value because it not only gives additional concrete information, but also because it raises the question of the proper use of laboratory results in improving manufacturing processes. It is well to emphasize the fact that a laboratory investigation of this kind is designed to develop information regarding the technic and the probable limits of composition as well as the effect of varying constituents in the compositions in order that defects may be corrected.

Mr. Lindemann's statement, that the various operators must become familiar with the preparation and application of a certain enamel to obtain best results, is very true. Enamel compositions developed in this as well as other investigations have given satisfactory results in some plants, while in others the reverse has been true, due undoubtedly to variations in technic encountered in the several plants. While the development in the laboratory of enamels applicable to all factory conditions is desirable, it is not to be presumed that all compositions so developed will prove practicable without their modification along lines suggested by the results of the systematic laboratory investigation.

Additional light can perhaps be thrown on the seeming discrepancies between the author's summary and Mr. Lindemann's experience by the following notes:

From the results of the preliminary work done at Mr. Lindemann's plant, Rg-7 was reported as having a comparatively short firing range and it was for that reason that it was not included in the list of the more promis-

ing compositions. Evidently Mr. Lindemann's operator is skilful enough to use it successfully, showing that we were playing over-safe in excluding it from the list of desirable enamels.

From our knowledge of these compositions it seems probable that Mr. Lindemann's objection to the cover enamels R-28 and R-18 was lack of opacity. These covers are more particularly adapted to those factory conditions, which are not uncommon, which make it desirable to use a cover which will cover satisfactorily in all cases even though it is necessary to apply several coats in order to attain sufficient opacity. Several compositions with particularly good texture and burning range but somewhat low in opacity were included to meet such conditions, and by no means should these be excluded from a field of commercially usable enamels.

WATER COOLING OF GLASS TANKS[1]

MR. PAYNE:—We have been very much interested in the subject of water cooling. About a year and a half ago we obtained a list of the companies having water coolers on their tanks. Included in that list were about fifteen different concerns. We sent out a questionnaire and in almost all cases I received answers. I will say that about ten of the companies replied that they had them in for a short time, but were unable to get definite results at the time of writing. About three or four of the companies were very enthusiastic about their use. Two were really noncommital or adverse to them. In those cases it seemed that the question of the purity of the water was a great factor. The real question, however, is whether 18- or 24-inch water coolers are desirable.

THE CHAIRMAN:—What contact do you have between the refractory and the metal container?

MR. PAYNE:—Simply a ground surface. We use no cement.

THE CHAIRMAN:—How long have they been in operation?

MR. PAYNE:—About a year. We are not saying very much about it, but they are a little better than the old style.

THE CHAIRMAN:—Has anyone else any experience with water coolers?

MR. YUNG:—I don't know, but I think that I was one of the first to start the water cooling proposition in glass house tanks. I might give you a little idea of the way the thing developed, and how disappointed I was at the finish. In the first place, we had a very corrosive glass, and the life of the tank was very short. I conceived what I thought a very brilliant idea one time of making a repair on the tank. The box was eaten through in spots, and it had been the practice of the men in the factory to pack this hot spot with the block, and the block on there would

[1] Glass Division, St. Louis Meeting, March 1, 1922.

overheat this particular spot. The glass came through, and I thought I had a wonderful scheme. By means of a piece of sheet iron I could distribute the heat developed on that particular spot over a larger area, the iron being a good conductor, and conduct the heat away from this hot spot. I tried that out and it worked very satisfactorily in sections over twelve inches square, and where the hot spot was perhaps five or six inches in diameter. On this water was turned, and the plate acted as no protection against the water. That held the tank with those holes in it, for a matter of six months, with these steel plates and the weak spot. And after that it looked so good, we tried the whole rear end of the tank with the sheet metal, covered it and pressed it up against the tank block as closely as possible, and put an extra underneath it to gauge the flow of water; in six weeks, as I remember, the whole melting end of our tank was eaten out. Then we made a hot repair and replaced the whole rear end of this tank and in the meantime with the hope of the thing being successful I had gone into the water jacket of the cooler. That happened to be installed before the development of this sheet on the back of the tank. These coolers were installed in short order. I think it was three or four months—and this tank went out. Considerable investigation was made of the blocks with accurate instruments, and it was readily seen by observation, whenever there was an opportunity of looking down between the water cooler jacket and the place. You could see the heat throughout the entire length of the furnace showing that instead of the blocks running cooler with the water jacket on it, they ran hotter, the explanation being that it was practically a loss, at least so far as getting a binder which would furnish a contact. Not having that, the air space in between acted as an insulator, and the coal ran hotter than it would without any cover on it at all.

MR. GRAFTON:—Speaking from the tank block manufacturer's standpoint, I don't believe there is any doubt but what a water cooled tank will get more service from the tank blocks than those without. I know several factories, one in particular, where they have an air cooled system, that is a volume of air blowing on all the joints, and I know this prolonged the life of that tank. At the same time, a glass company at Evansville, Indiana, have a system of their own, consisting of a two-inch pipe surrounding the tank filled with water, over the throat and everywhere, to resist the heat. They have also prolonged the life of their tank. At the Johnson Glass Company of Hartford City, the conditions referred to by Mr. Yung were different. The blocks were entirely gone around the dog house and were entirely eaten out to a point eighteen inches below the surface. The glass was resting against the water coolers. I was talking to a manufacturer not long ago in regard to the repairs of his tank. He was holding up the repairs because he was considering the installation of water coolers,

but he finally gave the matter up, for the reason that the cost of furnishing water to these coolers, even though they prolonged the life of his tank for six or eight months, would cost him more than repairing his tanks with new blocks.

MR. BROWN:—If you go into water cooling, you can easily use up 300,000 gallons a night.

MR. CHAIRMAN:—Use it up or circulate it?

MR. BROWN:—That is up to you.

MR. FORSYTH:—We are experimenting a little bit with this, but only a trifle. The amount of water required, even on a small cooler, is a large item. The first thing you have to consider is the amount of scale deposited by your water. What would be the efficient temperature to run your water from the overflow to these cooling tanks? If you were running the water straight through the cooler to the sewer, naturally you would want to run that at as high a temperature as possible. But apparently there is no data on the amount of the settling on any particular water as you raise the temperature from the temperature of the main to the boiling point, and the only way would be to have some kind of a cooling system —tanks or otherwise—in which you eventually move all the salts that will precipitate out of your water. Then the only amount of water you have to add from your mains is that due to evaporation during your cooling. Unfortunately, in our plant we are not situated so that we can install this kind of a system and we have to run the water into the sewer. It certainly requires a large amount of water, especially when you are not sure how much of the temporary hardness will be precipitated out. To my notion, it seems our waste water will run out at a low temperature, which is better than taking the chances of heating up and depositing scale, even though the water jackets are equipped with a so-called "wash-out" system.

MR. BROWN:—There is a difference between hard and soft water. You had better get your water softer if you are going to use coolers.

MR. FORSYTH:—In using the water over and over again, you eliminate that.

MR. BROWN:—It then comes down to a question of water purification.

MR. WILLIAMS:—I would like to suggest that water cooling is probably a step in the wrong direction in solving our tank problems; not but that water cooling might be a temporary remedy for maintaining the life of a tank, but after all, the weakness is in the refractory. Further cooling is carrying off a lot of heat rather than saving it, and after all is said and done, what we are after is heat economy as well as tank life. It should be "insulation" and not a matter of "cooling by water" which should be the solution of tank life and heat economy at the same time. I mention that point so that in this discussion we won't lose sight of the fact that maybe

that is not the right way to do it after all, but the ultimate desirable way is "insulation" and heat economy.

THE CHAIRMAN:—I notice Mr. Wright has just come in. I am sure he can contribute something to water cooling of tank blocks.

MR. WRIGHT:—I think my experience has been possibly of a practical nature, something similar to those who used the water jackets for cooling tank blocks. I notice that the tank blocks wear away faster at the start than if they are air-cooled. From the time the block begins to get thin down to the point where it is one or two inches thick, the water jacket seems to be of help. I have heard of several places where water jackets have failed, but it was not necessarily due to the fact they were water jackets. The experience at a plant not very far from ours was that about three weeks after they started they lost a tank, and I think it was due to the fact they had dirty water; they allowed the water jackets to become filled with sediments, and the water jackets acted as insulators rather than a cooling medium.

MR. BELLAMY:—I haven't had any experience with water coolers, but what has been said has resolved itself into a case of transferring the cold from the water to the tank blocks, and in those cases, where it has worked, it has been a case where the circulating water has cooled the block and the other was where the contact between the cooler and the block has not permitted the transfer.

THE CHAIRMAN:—Mr. Williams mentioned the case of a steel furnace. The steel men evidently have analyzed their costs, and they have come to the conclusion, that even though they do burn up a furnace in a short time, they are ahead of the game. But in the glass industry we perhaps don't realize the relative cost of material and tank refractories. I think if detailed costs were set up for tank blocks and refractories, we would find the cost of repair is insignificant compared with tonnage we can get off. In other words, what I am trying to say is, there is a point where we can force our tanks harder with shorter life and finally be better off than if we nurse along the tank blocks.

A MEMBER:—Doesn't that statement hold good as applied to water coolers? If you put a water cooler on the side of the tank, the only service it seems to me is to keep the block cool, to keep it from wearing away; that means you are taking heat away from your furnace continually, and not only have the cost of pumping the water, but also have the cost of heating that water, which naturally comes on your coal bill. And it seems to me the increased cost of fuel consumption or increased cost of the coal which you would be using would, to a very large extent, offset any advantage you would get from your water cooler, and you might be better off to allow your blocks to burn out and replace them more frequently, than to have a vapor heat that way.

THE CHAIRMAN:—That is something along the line I had in mind. It is an investigation of your cost as distributed over tank repairs and fuel cost. Fuel cost is a big item. Mr. Brown has said it takes 300,000 gallons of water a day to cool something or other down in Charleroi. 300,000 gallons of water a day certainly runs into money. I think it is up to the tank block people to give us blocks that won't corrode. I think we are all agreed on that. Let us hope that this is just a temporary expedient, and we will get refractories that will stand up. I think Mr. Williams' point on that is exceedingly well taken. Of course, I am in the glass business and not the tank block business.

ACTIVITIES OF THE SOCIETY

A MESSAGE FROM PRESIDENT RIDDLE

Membership

Our Sporting Editor, in the October issue of the *Journal*,[1] announced the close of the Base Ball Season.

Past experience has shown that football is far more popular among our members than base ball. It is reasonable to suppose that the same condition will continue this year. So far the 1922 reports show an increase of 189 personal and 60 corporation members.

Our athletic board is very capable and Athletic Director Purdy is too well-known to require an introduction. Some of you have not met Manager Bowman but you will hear more of him before the year is over. The publicity department, under the direction of Miss Van Schoick, is doing all that can be asked. It is understood on good authority, however, that Coach Binns is in need of more raw material if she is to develop seven good division teams. A good many are fine on the defensive but what we really need are a lot of good tacklers. Miss Binns believes in open play; in fact, she states that the farther you are from Columbus the better, as long as you tackle, as you may get somebody going around the end, with whom no one else could get in contact.

Advertising

A study of the financial statement for September and a comparison of the receipts and estimated income as shown by the Budget prepared last February bring out several interesting points. Our Budget shows an estimated income for 1922 dues and subscriptions of $20,500 while the receipts for the first nine months are very close to $17,000. This, the accounts receivable and the revenue to be received from additional memberships, provided you do all Coach Binns expects of you, will bring the total receipts from these two sources well up to the estimated figure.

The receipts from advertising, however, have not shown the increase which was anticipated nor which a great many feel the increase in the circulation of the *Journal* warrants. We have a capable, experienced advertising manager but no matter how hard he may work he will not be able to continue to sell advertising without your support. Advertisers primarily judge a journal by its circulation, considering not only the number of people reached but also the character of those people and their ability to buy the particular commodity which is being marketed. This primary judgment will sell advertising in the beginning but it will not continue to sell it unless the merchant feels he is getting proper returns.

Comparison of the total volume of business done before and after undertaking an advertising campaign is one method of determining the value of the advertising; however, a good many merchants keep account, as far as possible, of the increase in sales due to advertising in each particular medium. Here is where you can be of great benefit to the Society.

1. Do you read the advertisements in our *Journal*?
2. When you write to an advertiser in the *Journal* do you tell him you read his advertisement in the *Journal*?
3. When you read an advertisement in another journal that ought to be in ours, what do you do?

[1] *Bull. Amer. Ceram. Soc.*, **1**, 254 (1922).

4. Do you realize that if you interest somebody in placing a full page advertisement in our *Journal* for a year you are helping as much as if you secured sixty new personal members?
5. Should you be advertising in the *Journal?*

Please think these points over. Get in touch with our Advertising Manager, LEROY W. ALLISON, 170 Roseville Avenue, Newark, New Jersey.

PAGE THE CHEER LEADER!

The football squad of the American Ceramic Society has already made a record for itself. Two full teams are in the field and although nine or ten of the men are new material they are all making good.

Wainford was the big man of the team this month, as by several spectacular plays he gained forty yards in the second quarter and completed a forward pass to Bowman. Lemley also starred, making a twenty-yard gain around left end and completing a forward pass to Office. Parmelee, Rochow, Cox, J. B. Shaw, Lindemann, and Blumenthal made consistent plunges through the line for twenty yards each. H. S. Kirk on a trick play gained ten yards around right end and completed a forward pass to Rhead. O. O. Bowman 2nd was good for two forward passes. Substitutes were sent in at various times and showed much promise. Landrum, Rhead, W. J. Rees, G. H. Brown, Howat, Stern, Gaudette, Bales, Gilfillan, and Moulton were each good for ten yard gains, and Nickerson completed a forward pass to Office. The climax came, however, when in the last minute of play S. Momoki, the diminutive Japanese end, got the ball on a fumble and made a thrilling run for a touchdown. The referee unhesitatingly declared the game a victory for the October side, and nothing but the proximity of the ceramic department with its classes of earnest students pursuing solemn figures across mournful blackboards prevented the office force from doing a snake dance down the hall. The record of each man on the team follows:

	Personal	Corporation		Personal	Corporation
C. W. Parmelee	2		J. B. Shaw	2	
W. F. Rochow	2		W. C. Lindemann	2	
Paul E. Cox	2		H. S. Kirk	1	1
R. D. Landrum	1		Charles Gaudette	1	
R. H. Wainford	4	1	Geo. Blumenthal	2	
F. H. Rhead	1		C. E. Bales	1	
W. E. Lemley	2	1	J. M. Gilfillan	1	
W. J. Rees	1		D. A. Moulton	1	
G. H. Brown	1		O. O. Bowman, 2nd		2
W. L. Howat	1		F. P. Nickerson		1
Newton W. Stern	1		S. Momoki		3
			Office	2	3

Total: 31 Personal, 12 Corporation

The net increase for the first nine months of this year is:

	Personal	Corporation	Total
October 16, 1922	1567	211	1778
January 1, 1922	1350	139	1489
Net increase	217	72	289

The gross increase in membership by periods since June 1921 is:

	Personal	Corporation	Total
June to September 1921	41	11	52
September to December	18	2	20
December to February	136	21	157
February to May	81	10	91
May	13	13	26
June	13	5	18
July	25	11	36
August	20	5	25
September	31	11	42
October	31	12	43
	409	101	510
Loss	82	5	87
Net increase	327	96	423

NEW MEMBERS RECEIVED FROM SEPTEMBER 15 TO OCTOBER 15

ASSOCIATE

Archie, Charles L., Box 265, Corinth, Miss., Supt., Corinth Brick Co.

Armstrong, Robert E., 312 East 13th St., Indianapolis, Ind., Salesman, Harbison-Walker Refractories Co.

Atwell, Donald B., 4447 Washington Blvd., St. Louis, Mo., Evens & Howard Fire Brick Co.

Bisby, Grace Griswold, Pinos Altos, New Mexico, Supt., Grant County Schools.

Camp, Arthur D., Box 503, Williamsport, Pa., Supt., Williamsport Building Products Co.

Carter, J. Guild, Trenton Flint and Spar Co., Trenton, N. J., Sales Representative.

Chiang, Kuan-Tsen, 1305 Yale Station, New Haven, Conn., Student.

Coss, Harold T., Y. M. C. A., New Brunswick, N. J., Student, Rutgers College.

Cuffin, John, 208½ North 22nd Street, Portland, Oregon, Supt., Denny-Renton Clay and Coal Co.

Girling, William G., c/o Henry Foster & Co. Ltd., Backworth, Newcastle-on-Tyne, England, Director and Works Mgr.

Habas, Sol, 634 S. Warren St., Trenton, N. J., Student, Rutgers College.

Hanna, Ralph E., 149 Rector St., Perth Amboy, N. J., Chemist, Atlantic Terra Cotta Co.

Hoehn, Charles J. P., 2902 Nineteenth St., San Francisco, Cal., Pres., Enterprise Foundry Co.

Holley, Kenneth E., Alfred, N. Y., Student, New York State School of Ceramics.

Howes, George W., Dowagiac, Mich., Gen. Supt., Beckwith Co.

Johnson, A. G., 115 Hyland Ave., Ames, Iowa, Student, Iowa State College.

Kane, Evan O'Neill, Jr., Kushequa Brick Co., Kushequa, Pa., Asst. Mgr.

Ludlow, George M., 565 Washington Blvd., Chicago, Ill., Pres., Sanitary Scales Co.

McAfee, William K., 305 Highland Ave., New Castle, Pa., Engineer, Universal Sanitary Mfg. Co.

McCall, Gilbert, 685 Thurman St., Portland, Oregon, Foreman, Denny-Renton Clay and Coal Co.

Martin, George M., 894 E. State St., Trenton, N. J., Keystone Pottery Co.

Mason, T. Harry, 45 S. Hermitage Ave., Trenton, N. J., Supt., International Pottery Co.
Ockerman, Elmer H., Alfred, N. Y., Student, New York State School of Ceramics.
Schepers, Francis A. H., 1021 Emerald Ave., Chicago Heights, Ill., Chemist, Advance Terra Cotta Co.
Sheerar, Leonard F., Alfred, N. Y., Student, New York State School of Ceramics.
Smith, Leon B., Alfred, N. Y., Student, New York State School of Ceramics.
Snyder, Hiram T., Louisville Pottery Co., Louisville, Ky., Gen. Mgr.
Turner, William, 837 Plum St., Trenton, N. J., Trenton Potteries Co.
Wainford, Henry R., Jr., 2241 Chestnut Ave., Trenton, N. J., Asst. Supt., Trenton Flint and Spar Co.
Willson, B. W., 322 Seventh St., Ames, Iowa, Student, Iowa State College.
Wysor, D. C., 40 Rector St., New York City, Mgr., Missouri Field, General Chemical Co.

CORPORATION

Canadian General Electric Co., Toronto, Ont., Canada.
Denny-Renton Clay and Coal Co., Seattle, Wash.
The Electrical Refractories Co., East Clark St., East Palestine, Ohio.
Globe Brick Co., Box 765, East Liverpool, Ohio.
Hardinge Co., Inc., 120 Broadway, New York City.
Iron City Sanitary Mfg. Co., 1514 Oliver Bldg., Pittsburgh, Pa.
Nippon Gaishi Kwaisha, Higashimatch, Nagoya City, Japan.
Nippon Toki Kwaisha, Noritake, Nagoya City, Japan.
Toyo Toki Kwaisha, Shinozaki, Kokura City, Japan.
The W. S. Tyler Co., Cleveland, Ohio.
Universal Sanitary Mfg. Co., New Castle, Pa.
Wainford Darling Co., Trenton, N. J.

WHO'S WHERE IN THE AMERICAN CERAMIC SOCIETY?

Howard C. Arnold has notified the office of a change of address in St. Louis, Mo., from 4906 McPherson Avenue to 4020 McRee.

Erling E. Ayars, of the American Refractories Co., has been transferred from Devils Lake, Wis., to Joliet, Ill.

W. W. Coates, Jr., has moved from Lawrence, Kansas, to St. Joe, Mo., where he may be addressed at the Y. M. C. A.

Earl Curry, of Willoughby, Ohio, who graduated from the ceramic department of Ohio State University last June, has accepted a position with Gladding McBean & Co., at Lincoln, Cal.

R. P. Herrold, of Zanesville, Ohio, where he is with the Mosaic Tile Co., has moved from Brighton Blvd., to 325 Adair Ave.

Herford Hope recently sent in to the office his new address which is, Liverton, near Newton Abbott, Devon, England.

C. E. Jackson, of the Warwick China Co., Wheeling, W. Va., has just returned from a trip to Europe.

Thos. N. Kurtz has severed his connection with the Standard Refractories Co. and has moved to 524 Penn St., Hollidaysburg, Pa.

P. William Lee, of Denver, Colo., has moved from Race St. to 507 Downing St.

Donald M. McCann, formerly of Zanesville, Ohio, has taken a position with the Sterling Grinding Wheel Co., Tiffin, Ohio.

F. L. Steinhoff, Managing Editor of *Brick and Clay Record,* has changed his residence in Chicago from Kedzie Ave. to 1122 East 67th St.

W. J. Sutton, a graduate student and assistant in chemistry at the University of Pittsburgh, has moved from Bellefield Ave. to 328½ N. Craig St., Pittsburgh.

Boris Trifonoff, formerly with the American Encaustic Tiling Co. at Zanesville, may now be found at 1244 N. Elm St., Muncie, Ind.

SOME OF THE LOST ARE FOUND

The Secretary acknowledges with appreciation information received from members of the Society with regard to the lost addresses printed last month. Six names have been restored to the rolls. The remaining unknowns are here listed in the hope that further information will be forthcoming.

Baker, G. V., Penn Feldspar Co., Philadelphia, Pa.
Bickel, Earl A., Postville Clay Products Co., Postville, Iowa.
Bramlett, Mrs. J. T., Enid, Miss.
Brett, R. C., Southern Clay Mfg. Co., North Birmingham, Ala.
Callaghan, J. P., c/o Teaque Hotel, Montgomery, Ala.
Dolley, Charles S., Keramoid Mfg. Co., Fort Madison, Iowa.
Greenwood, John L., Lehigh Sewer Pipe and Tile Co., Lehigh, Iowa.
Groocock, Alice, 865 Bathurst St., Toronto, Ont.
Henshaw, S. B., Libbey-Owens Sheet Glass Co., Charleston, W. Va.
Kitamura, Y., Shofu Kogo Kafushiki Kaisha, Kyoto, Japan.
Knote, J. M., Mines Dept., Sault Ste. Marie, Ont.
Lodwick, J. A., American Arch Co., 17 East 42nd St., New York City.
Meissner, Max, Sprague Canning Machine Co., Hoopeston, Ill.
Miller, J. J., Mellon Institute, Pittsburgh, Pa.
Mitchell, Leon W., Rock Island Stove Co., Rock Island, Ill.
Morrow, Robert P., Harbison-Walker Refractories Co., 1513 Rockefeller Bldg., Cleveland, Ohio.
Pendrup, W., Coonley Mfg. Co., Cicero, Ill.
Pire, Mrs. Ward L., 1745 East 116th Place, Cleveland, Ohio.
Pulsifer, H. M., Geo. H. Holb & Co., Chicago, Ill.
Ragland, N. A., Alberhill Clay and Coal Co., Los Angeles, Cal.
Reid, W. H., 10 Stanley Place, Yonkers, N. Y.
Risch, Edward J., 4935 Roscoe St., Irving Park Sta., Chicago, Ill.
Smith, Harry W., Roessler & Hasslacher Chemical Co., Box 360, Cleveland, Ohio.
Stewart, John G., 530 Union Trust Bldg., Cincinnati, Ohio.
Tefft, T. D., Hamilton, Ont.
Vodick, William J., 1733 Lake Ave., Wilmette, Ill.
Walcott, A. J., Bausch & Lomb Optical Co., Rochester, N. Y.
Yamamoto, Tamesburo, Yamatame Glass Mfg. Co., Osaka, Japan.

TWENTY-FIFTH ANNUAL MEETING

Silver Jubilee

Plans are being made for an unusually important program at the annual meeting in Pittsburgh, February 12–16, 1923. Leading men in ceramics and allied industries will be invited to participate in the opening session; the charter members of the Society will be honored at the banquet; and each division will have four sessions for the presentation of papers and discussion.

Since the January number of the *Journal* is to be devoted to a review of the history of ceramics and of the Society for the twenty-five years past, the period of the annual meeting will be devoted to a consideration of present and future problems.

A strong local committee has been appointed under the chairmanship of A. F. Greaves-Walker. The personnel is as follows:

EXECUTIVE COMMITTEE

A. F. Greaves-Walker, *Chairman*
E. W. Tillotson, *Vice Chairman*
R. M. Howe
A. Silverman
J. W. Hepplewhite, *Secretary*

RAILROAD TRANSPORTATION

C. C. Phillips, *Chairman*
Robert F. Ferguson
J. E. Hansen

HOTEL ACCOMMODATIONS

A. H. Chandler, *Chairman*
A. E. Blake
J. L. Crawford

PUBLICITY

Arthur W. Kimes, *Chairman*
John M. Hammer
E. W. Tillotson

SERVICE

H. G. Schurecht, *Chairman*
H. G. Elledge
Arthur E. Gray
Willard J. Sutton
W. F. Wenning

SMOKERETTE

Raymond M. Howe, *Chairman*
F. G. Lord
H. S. Robertson
Drew M. Thorpe

BANQUET

Alexander Silverman, *Chairman*
M. G. Babcock
H. L. Dixon
F. W. Donahoe
C. R. Peregrine
Francis W. Walker, Jr.

RECEPTION

J. Spotts McDowell, *Chairman*
Chas. R. Fettke
Francis C. Flint
H. C. Fry
Samuel M. Kier
Chas. J. Kirk
Donald W. Ross
H. G. Willets
E. J. Winkleman

FINANCE

Henry L. Dixon, *Chairman*
Marion G. Bryce
Porter Kier
J. M. Lambie
Kenneth Seaver
Thos. Wilson

ENTERTAINMENT OF LADIES

Mrs. A. F. Greaves-Walker, *Chairman*
Miss Edna P. Carson
Miss Mabel C. Farren
Mrs. H. L. Dixon
Mrs. R. M. Howe
Mrs. Alexander Silverman
Mrs. E. W. Tillotson

TRIPS

J. Spotts McDowell, *Chairman*
D. M. Buck
J. W. Cruikshank
L. P. Forman
Marsden H. Hunt
F. K. Pence
Francis W. Walker, Sr.

A Letter from the Pittsburgh Chairman

Pittsburgh, Pa., October 17, 1922

To the Members of the American Ceramic Society:

The next annual meeting of the Society will be held in Pittsburgh, Pennsylvania, February 12 to 16. This will be the twenty-fifth anniversary of the birth of the Society and we are, therefore, referring to it as the Silver Jubilee Convention. Pittsburgh was selected for the celebration of this occasion because it was in this city that the original plans for the Society were laid twenty-five years ago.

The Local Committee, in conjunction with the officers of the Society, are planning to make this the biggest and most enthusiastic meeting the Society has ever held, and it is hoped that every member of the Society will accept this as a most cordial invitation to be present. It is confidently expected that from seven hundred to eight hundred members will attend.

The Local Committee has already laid its plans. The general meeting will be held at the William Penn Hotel, which will also be headquarters for the Society, on the 12th, as will also the Banquet on the evening of that day. On the evening of the 14th the Smokerette, which will this year include dancing, will be held at the William Penn. The Fort Pitt Hotel will be used for Divisional Meetings, of which this year there will be four instead of three as in previous years. The evening of the 13th has been purposely left open by the Committee with the idea that it could be used for little social gatherings and for Alumni dinners and meetings.

It is planned by the officers of the Society to invite for this Silver Jubilee Convention a number of the most prominent scientific and technical men in the country and it is expected that several of these will be heard at the Banquet. It is expected that there will also be a full attendance of the charter members now living, which will add greatly to the occasion.

Plans have been made to entertain the largest attendance of ladies and it is sincerely hoped that every member who can will make it a point to bring his wife with him.

On account of the large attendance expected it is not too early to make hotel reservations. This can be done by addressing either the William Penn or Fort Pitt Hotels, or the Chairman of the Local Hotel Accommodations Committee.

Sincerely yours,
(Signed) A. F. GREAVES-WALKER, *Chairman,*
Executive Committee, 25th Anniversary Meeting

REPORT OF COMMITTEE ON RULES

Amendments to the Constitution

Herewith are amendments covering two classes of memberships (*a*) *Ex Officio* Honorary, (*b*) Perpetual. These were proposed in August 1921, were considered and finally approved by Committee on Rules and Committee on Membership acting jointly. They were not presented to the Society at the St. Louis Convention so as to give the 1922 Rules Committee opportunity to review them. They were finally presented at the September 15, 1922 meeting of the Society in New York City.

Ex Officio Honorary Members: This Society has at times honored officers of the ceramic societies of other countries by electing them to honorary membership during the term of their official incumbency. No distinction has heretofore been made between our "life" Honorary and these "temporary" Honorary memberships.

Perpetual Active Memberships: The conception behind provisions here proposed cover the "life" membership and the "permanent endowment" ideas with which our parliamentarians have for long been working. The amendments here proposed give opportunity to pay an endowment fee, the interest earnings of which will cover all regu-

lar dues during the life of the member as in the customary "Life Memberships;" and at the death of the member the fee will be transferred to a permanent research endowment fund, and the name of the member forever kept on the roster of the Society appropriately designated as having so contributed to the support of the work of the Society.

Proposed Amendments to Constitution and By Laws

Article II

#1 The Society shall consist of Honorary, *Ex Officio* Honorary, Active, Perpetual Active, Associate, Corporation and Industrial Association and Perpetual Corporation Members.

#4 *Ex Officio* Honorary Members must be such officers of such other associations and societies as shall be unanimously designated by the Board of Trustees, the name of the person holding such office appearing on the Society roster as *Ex Officio* Honorary Members during the term of his incumbency only.

#5 Same as present #4.

#6 Same as present #5.

#7 Perpetual Active Members must be those members, active or associate, who make single payment of an endowment fee as prescribed in Article III. Their names shall appear on the Society roster perpetually. Perpetual Active Members shall have the same rights as Active Members.

#8 Same as present #6.

#9 Same as present #7.

#10 Perpetual Corporation Members must be persons, firms, or corporations who make single payment of an endowment fee as prescribed in Article III. Their names shall appear on the Society roster perpetually. Perpetual Corporation Members shall have the same rights as Corporation Members.

#11 Same as present #8.

#12 All Honorary Members, *Ex Officio* Honorary Members, Active Members, Perpetual Active Members, Associate Members, Corporation Members, Perpetual Corporation Members and Industrial Association Members shall be equally entitled to the privileges of membership, except that only Active, Perpetual Active, one representative of each Corporation Member, and one representative of each Perpetual Corporation Member shall be entitled to vote. Such representative shall be officially designated by the person, firm or corporation represented. Only Active and Perpetual Active Members shall be entitled to hold office. The roster of each grade of membership shall be printed separately in at least one publication issued by the Society annually.

#13 Any person may be expelled from any grade of the membership of the Society if charges signed by five or more Active or Perpetual Active Members be filed against him or her, and if the Board of Trustees examine into and sustain said charges by a majority vote. Such person, however, shall be notified of the charges against him and be given a reasonable time to appear before the Board of Trustees or to present a written defense before final action is taken. In case of such expulsion, any moneys paid the Society as endowment fees become forfeit to the Society and automatically become part of the research fund.

Article III

#1 Honorary and *Ex Officio* Honorary Members shall be exempt from all fees and dues.

#3 Perpetual Active Members shall pay a single endowment fee of $200.00,

the interest earnings from which shall be used during the life of the member for current expenses. Upon the death of the member, the interest shall be used according to the direction of the Board of Trustees for ceramic research. The privileges of membership shall begin upon payment of this fee.

#4 Same as present #3.

#5 Perpetual Corporation Members shall pay a single endowment fee of $600.00, the interest earnings from which shall be used for current expenses for a period of twenty-five years after which time the interest shall be used according to the direction of the Board of Trustees for ceramic research. The privileges of membership shall begin upon payment of this fee.

#6 Same as present #4.

T. A. KLEINFELTER,
Chairman, Committee on Rules

AMENDMENTS PROPOSED BY TEN MEMBERS

Article XII of the Constitution makes provision for any ten members presenting proposed amendments the same to be read at a regularly called meeting of the Society and voted upon by letter ballot by the Active Members. The following two amendments were thus presented by Mr. Homer F. Staley and nine others:

(1) **Elimination of "Associate" Members.**

Article II.—Membership

(1) The Society shall consist of Honorary, Active, Corporation and Industrial Association Members. All members of the former "Associate" grade are hereby made Active Members.

(4) Eliminate.

(5) Eliminate.

(6) Active Members must be persons interested in the ceramic or allied industries.

(9) Eliminate "Associate Members."

Article III.—Dues

(2) Eliminate "and Associate."

By-Laws

Section IV. Eliminate "and Associate."

Section VII. (3) Change "Associate" to "Active."

(2) **Change in Board of Trustees and Method of Electing the Board Members.**

Article IV.—Officers

(1) The affairs of the Society shall be managed by a Board of Trustees consisting of the President, the Vice-President and as many Trustees as there are Divisions of the Society. The President and Vice-President shall be elected as prescribed in Article V to serve one year. One Trustee shall be elected annually by ballot by each Division at the last session of the Division held during the annual meeting of the Society. A Trustee may be reëlected to serve not more than three consecutive years.

(9) A Treasurer shall be appointed by the Board of Trustees for a term of not more than two years. (Then continue as formerly.)

Article V

Eliminate "Treasurer and one Trustee." Put "and" between "President" and "Vice-President."

SHALL I JOIN THE SOCIETY NOW?

At this time of year new members are sometimes dismayed at the information that payment of dues now does not preclude the receipt of a bill for 1923 dues on January first, since all memberships are considered as extending from January to January, and payment of dues at any time of the year entitles a member to all the *Journals* for that year.

The reasons for this practice are two. Most members wish to have the *Journal* in complete volumes, and the Society finds it advantageous to keep the stock of the different numbers as uniform as possible.

"But," we hear someone say, "I don't want to receive nine or ten *Journals*, back numbers, all at once."

The answer to this is found in the casual remark of a Columbus man who joined the Society in September. He came into the office one morning and said, "Well, nine *Journals* arrived in my mail this morning and I have glanced at the tables of contents. I see thirty articles of direct interest to me and many more of indirect interest."

We thanked him and jotted this down on our solid ivory tablets for use in the Bulletin.

We believe that a man who joins the Society in September, or even December, and pays a year's dues, gets his money's worth before he receives a bill for the new year's dues in January. The Annual Meeting, with each of the seven divisions carrying a crowded program, provides papers for the entire year, so that most of the material appearing in the last issues of any year are no older, so far as investigation and experiment are concerned, than those which are used in the earlier numbers. Then too, discussions printed in November, for example, may refer to original papers printed in May; while the index in the December number would be of little importance to a member if the last two or three numbers only were in his possession.

New applicants are given a chance to elect whether they will join as of the old year or as of the coming year, when they are accepted for membership during the last three months. But we feel that, did they understand what they would receive or what they would miss, according to their decision, there would be little hesitation about paying dues at once, regardless of the fact that another bill would be forthcoming in January. Furthermore, three months' grace is given for the payment of the January bill.

REPORT OF COMMITTEE ON NOMINATIONS

Officers for 1923 and Trustee to Serve Three Years

For President, A. F. GREAVES-WALKER
For Vice-President, ROBERT D. LANDRUM
For Treasurer, RALPH K. HURSH
For Trustee, RALPH R. DANIELSON

ABSTRACTLY SPEAKING

It is a matter of pride in the editorial office and, we hope, satisfaction to the members of the Society, that the number of Abstracts from our own staff is increasing. This month, out of 164 abstracts, 116 are from our own abstractors. It has been our aim to have the ratio of our own Abstracts to those from *Chemical Abstracts* at least 2 to 1, and not 1 to 2 as it had to be before we were "abstractedly self-supporting." J. L. Crawford, J. W. Hepplewhite, R. M. Howe, H. P. Hood and R. R. Danielson have been added to the list of abstractors.

NORTHERN OHIO SECTION

The sixteenth regular meeting of the Northern Ohio Section was held on October 10, at Hotel Winton, Cleveland. Lunch was served at 1 P. M. after which the technical program was taken up.

Mr. B. A. Rice, ceramic chemist with the Elyria Enameled Products Company, introduced a discussion of the determination of the physical properties of enamels, such as the coefficient of expansion, adhesion, and the elasticity. These three are the properties which would seem to be connected with the tendency to fishscale. An interesting account was given of experiments made on enameled ware, and of attempts to form the enamel into a rod or bar by pouring into heated molds, also suction. The problem of forming a specimen of accurate, uniform dimensions seems to be the greatest stumbling block.

Mr. J. H. Forsyth, Glass Technology Department of the National Lamp Works, gave a lively account of the main features of the Society's Canadian trip.

A visit was made by some of the members to the Research Laboratory of the National Malleable Castings Company, where the unusual facilities for high temperaure work and mechanical testing proved of great interest.

A. F. GORTON, *Secretary*

NEW ENGLAND SECTION

At a special meeting of the Executive Committee of the New England Section, O. S. Buckner was appointed Chairman and C. W. Saxe, Secretary, for the balance of the year 1922. Both Mr. Buckner and Mr. Saxe are with the Norton Company, Worcester, Mass. Plans are being made for a meeting of the Section at Worcester on October 28.

NOTES AND NEWS

THE PROBLEM OF PLASTICITY TO BE STUDIED

THE RESEARCH COMMITTEE, WM. H. CLARK, CHAIRMAN, MAKES THE FOLLOWING ANNOUNCEMENT

Of prime importance to ceramists is the proposed research to be pursued at Lafayette College, Easton, Pa., under Professor Eugene C. Bingham, on the fundamental problems of plasticity, provided funds to finance the work are forthcoming.

Those who have seen his invaluable book "Fluidity and Plasticity,"[1] recently published, will not question Professor Bingham's authority and power to handle this subject.

The Research Committee of the American Ceramic Society endorses the proposed plan of research and urges individuals and firms to contribute to the fund for the purpose.

The General Electric Company has subscribed $1,000 with this comment:

"We had your book of the Talbot Series, and it seemed to us that, if any type of research outside of our strict local laboratory undertakings should receive financial assistance from this Company, it is that which you are carrying on."

Subscribers may send their contributions to R. C. Purdy, General Secretary, American Ceramic Society, Lord Hall, Ohio State University, Columbus, Ohio, with the assurance that such will be promptly forwarded.

Professor Bingham's clear statement of the needs and purposes of his plan follows:

Dear Sirs:—

For several years research work on the subject of plasticity has been carried on at Lafayette College, in the Gayley Laboratory. The results are now generally available in

[1] See review, *Ceram. Abs.*, **1**, 172(1922).

a book published by McGraw-Hill Book Co., entitled "Fluidity and Plasticity." Enough has been done to show that paint, rubber, nitrocellulose, starch, metals and their alloys, road-building materials, and many other colloids are plastic materials and not viscous liquids as heretofore assumed. This changes our conceptions, for we are really dealing with two properties, yield value and mobility, instead of the one property, viscosity. The relationships are apparently governed by simple laws, but our knowledge of the whole subject is very fragmentary.

We have an Edward Hart Fellow and a du Pont Fellow engaged in working out these problems, but the work is painfully slow and with a full schedule of teaching I have little time myself either for research or for directing the research of others. Lafayette College, through President John H. MacCracken, has agreed to give me practically my entire time for research, provided that $3,600 a year can be secured for the employment of another man to carry the elementary teaching, which is now a part of my work. The college will of course furnish the laboratory space, equipment, etc.

Several firms have shown interest in the work on plasticity and have offered to coöperate in a variety of ways, which prompts me to write this letter. From the nature of the work in which you are engaged, I believe that you are interested from a practical point of view in seeing our knowledge in this new field greatly amplified, just as the writer is from a scientific point of view.

My own interest in this work is such that I agree to give $1,200, which is one-third of the whole amount required, out of my own salary, and I only regret that I cannot do more. Perhaps, however, even this will indicate good faith.

In case we can raise $3,600 for the year 1922–23 the entire time of one man will be devoted to research and its direction.

It is proposed to make a study of the fundamental problems of viscous and plastic flow, and it is hoped that the results may be applicable to all colloid problems and not limited to problems of flow in a single industry. The results of the research will be made available through publication.

Will you or your firm share in establishing this fund for research in plasticity for the year 1922–23?

Respectfully yours,

(Signed) EUGENE C. BINGHAM

Chairman of Lafayette College Research Committee

COÖPERATIVE RESEARCH[1]

The Advisory Council in their Seventh Annual Report to the Privy Council for Scientific and Industrial Research tells of the research organizations and of the work being accomplished in England. We wish it were possible for every member of the Society to have a copy of this report because of the inspiration for coöperative research with which it teems. We quote here only a few paragraphs covering the objects and methods under their system of coördinated government and industrial supported research.

"The problem before the country, as we see it, is to provide a means which will enable its population of nearly 50,000,000 to live and prosper. It is well recognized that for four-fifths of their food and for a great part of the necessary raw and semi-manufactured materials for industry, the people of these islands are dependent on supplies from overseas. These supplies can only be obtained if this country is able to carry on its exporting industries in future with greater efficiency than the rest of the world, for it is doubtful whether we can compete, either by lowering wages beyond the limits of our competitors, or by securing a much greater human effort than they. If these two avenues are closed, competition, in the end, is confined to greater efficiency resulting from scientific work, for, in the long run, our outstanding business skill and organisation could not make good a deficiency of production or an obvious inferiority in our goods. We consider that scientific and industrial research, along the lines which

[1] Extracts from Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1921–22, England.

we have laid down and on which we have been building during the past seven years, is an essential factor in the national effort on which the continued maintenance of our present population unquestionably depends."

"The utmost use must be made of the natural resources we possess, and at each stage through which our raw materials pass in their evolution from the natural state to the most highly finished product, the utmost efficiency of the machinery employed and the human skill applied must be secured if we are to succeed. The fullest utilisation of the discoveries and methods of science, through close association with industrial effort, alone can ensure the achievement of this end."

Research Associations

"Twenty-four research associations have received licenses from the Board of Trade and twenty-two of these are in active operation. In addition, three other industries have the possibility of forming such organisations under immediate consideration and research associations are likely to be launched in these cases in the near future. Preliminary negotiations are taking place with several other industries.

"Of the twenty-two associations referred to above, two have at the date of this report just passed into their fifth year of grant aid and four others have commenced their fourth year; nine associations are in their third year and seven are in their second year.

"When the Government scheme for industrial research was started it was thought that a period of five years would give reasonable time for an industry to test and try the value of coöperative research; for this reason the offer of grant assistance was made for a quinquennium in each case. The scheme cannot be described as an experiment in the value of research as applied to industry, for long before the scheme was instituted a number of firms possessed successful research laboratories; no experiment was needed to prove to these the value of scientific research. But privately organized and financed laboratories were only for the wealthy corporations; the smaller firm could not hope to face the outlay and the annual charges involved, however much it might be convinced of the utility.

"There are many indications that the industrial world is tending to move from an age of pure competition between firm and firm to one in which the element of competition will be merged in emulative coöperation. The scheme is in general consonance with this tendency, though the success of the movement as a whole may only be partial, and actual failure may occur in individual instances, for the economic conditions which have prevailed during recent years have been exceptional and have put obstacles of a most formidable type in the way. For this reason the five-year period has been a less effective test of the ultimate usefulness of coöperative research than it would have been under more normal conditions. In any case, five years is no lavish space in which to set on foot an institution, to equip it with men and material appropriate for its purpose, and to produce results sufficient in value to prove the worth of the undertaking.

"Experience has shown that the best part of two years is required before the organisation can be said to have got into its stride and to be in a position to attack its problems. If in the following three years some results of value emerge, then there will be justification for the State's educational endeavor and for the faith of the pioneers in the various industries to whom the movement owes so much. That results of value will come sooner or later we have no shadow of doubt, but we trust that, if in certain instances they do not come sooner, the particular industry and its upholders will not give up hope. When times are bad and every item of expenditure has to be narrowly scanned, the subscription to a research association which has not yet produced tangible results may seem to be an addition to the budget of dubious value, even though it

may be no more than a workman's or foreman's wage for the year. The cost of supporting research cannot indeed be justified by comparing it with the prime cost of production—especially when demands are falling off—but by the consideration that it is the means of improving and cheapening production and, in consequence, of increasing the demand. Research, as we have often pointed out, is a cost in the same category as insurance. It is an insurance against the effects of ignorance with the certainty, if it is wisely undertaken, of large and continuous bonuses."

Coöperation

"We have said that the Government scheme of aid to industrial research is an educational venture. It is experimental in the sense that it is an attempt to establish coöperative research in this country, and the experiment has been opportune. At the very moment when private industrial research organisations have found it necessary to diminish their expenditure and, consequently, to curtail their activities, established research associations, with a guaranteed income during their first five years of existence, have been given the certainty of being able to arrange their programmes without fear of drastic economies during that period. No coördinated scheme of work can be devised and followed unless an assured and sufficient income is available for its prosecution. A staff, however devoted, cannot be expected to give single-minded attention to their work if they are anxious as to their future for reasons in no way connected with their efficiency.

"Coöperation is the essence of the scheme and every year shows fresh directions in which team work in the widest sense can serve a useful purpose. Firms of varying size and financial strength can pool their resources according to their standing and can enjoy the results which that partnership secures. To the smaller firms this is of particular value for, otherwise, research work and the expense it involves would not be within their powers. Team work within an association is also of the first importance. A research worker thrown among a number of his fellows with whom he can confer, compare notes, and consult, has more chance of producing results than he would have in the isolation, or in the comparative isolation, of a smaller organisation, especially when he has the advantage of serving under a chief with wide vision and experience.

"During the past year, fresh evidence of the value of coöperation has been forthcoming in other directions. In several instances, two or more research associations have found it profitable to join forces in attacking some common problem, realising that each can supply something of use to the other to their mutual advantage. Thus the British Cast Iron Research Association and the British Refractories Research Association are joining forces in investigating sands and refractories. The Research Association of British Motor and Allied Manufacturers and the British Cast Iron Research Association are jointly dealing with the casting of cylinders, while the important subject of die-castings is being approached by the Research Association of British Motor and Allied Manufacturers, the British Non-Ferrous Metals Research Association, the British Scientific Instrument Research Association and the British Electrical and Allied Industries Research Association, in collaboration. Again, the Glass Research Association and the British Refractories Research Association have joined in an investigation into the refractories used in the glass industry. Further coöperation between research associations and various Government departments has been found possible and mutually beneficial.

"Thus it is that the scheme, which was designed primarily with the object of cooperative endeavour on the part of individual firms in the same industry, is becoming the means of bringing still larger interests together for a common purpose. This principle is likely to prove a prominent factor in organised industrial research of the future. The raw material in one industry is the finished product in another; it must be to their

common advantage for the makers of the two to come together. We have discussed elsewhere the conditions under which it is possible to combine producers and users in a single research association and these necessary conditions are not often found to be present. But although the producer is better able to conduct researches for the development of more economic processes or improved products than is the user, he often needs the necessary stimulus. The Gas Companies desire gas stoves to be more economical because they realize that while the consumption of their product would be less per stove, the number of users would be vastly increased. But, because the consumers were unorganised, it took the Gas Companies a long time to discover this simple truth. Research associations bring about an organised criticism of the product used in their industry and thus lead the way to improved production by the manufacturers of the materials they use. Coöperation between a research association of producers and a similar association of users thus becomes simple and natural within the limits of their common interests. Many examples of this tendency could be cited and the principle was clearly before the eyes of the Government in founding the scheme, for it expressly provided means for coöperation between different research associations in attacking specific problems."

Headquarters of Research Associations

"Some research associations have their own laboratories, some rent suitable accommodation from universities or other public institutions, and some delegate the whole of their work to experts engaged in universities or elsewhere. There is evidence that, wherever possible, it is advantageous to an association to have its own research station. The advantage lies not only in the concentration of a staff and their research work under the eye of the Director, but in the fact that the existence of the research station stimulates the interest of the members of the association. If a member can enter a research institute created by the association of which he is a supporter, he feels a sense of ownership and a keener interest in its work. This interest is essential to the permanent success of the undertaking. Moreover, when Government grants cease at the end of the quinquennial period, the existence of a fully equipped research establishment will be a further incentive to the members to see that its continued maintenance is not jeopardized by lack of funds. The good will of a research association will be larger in the case of an association in possession of its own headquarters than in the case of one which has conducted purely extra-mural operations.

"Research associations have proceeded in the matter of headquarters along different lines. The British Cotton Industry Research Association has an annual income at present of about 20,000 pounds a year; in addition it received a large grant from the Trustees of the Cotton Trade War Memorial Fund. With funds of this order behind it, and with over 90 per cent of the firms in the whole industry members of the Association, the Council was in a position to acquire and equip premises on a large scale. The Shirley Institute, as the headquarters of the Association is called, consists of a large mansion standing in $14^1/_2$ acres of freehold land. The house has been fitted up to provide accommodation for a library and information bureau, a council chamber, refractory and administrative offices and residential accommodation for certain members of the staff. In the grounds have been erected up-to-date and well-equipped laboratories on the most modern principles; in addition, there is a series of workshops for the construction and repair of instruments used in the laboratories and for the general maintenance of the Institute. In another part of the ground eleven houses have been erected for the use of married members of the staff.

"The British Cotton Industry Research Association has been honoured by a visit from H. R. H. the Duke of York, K. G., who declared the Shirley Institute open on March 28, 1922. We realize that by this gracious act His Royal Highness has conferred the

benefit of Public recognition not only on the British Cotton Industry Research Association but on the movement for industrial research as a whole.

"Less wealthy associations have had perforce to content themselves with less ambitious homes but several have acquired properties which have been adapted to provide commodious and convenient laboratories. The Linen Industry Research Association has acquired a large house standing in 22 acres of ground which is almost as impressive as the Shirley Institute, the laboratories in this case being provided in the house itself. The British Research Association for the Woolen and Worsted Industries and the British Portland Cement Research Association also own substantial establishments.

"In several cases, for example, the British Scientific Instrument Research Association, the Glass Research Association, the Research Association of British Rubber and Tire Manufacturers, the British Association of Research for Cocoa, Chocolate, Sugar, Confectionery, and Jam Trades, private residences in London or the suburbs have been acquired and adapted with excellent results. A private residence of the proper size can be converted at a relatively low cost into a convenient and efficient research establishment. Private houses, with large basements but of substantial size and structure, can now be acquired at reasonable prices owing to the disfavour into which residences of this type have fallen. But the inconveniences which they present for domestic use are no serious drawback from an association's point of view. The despised basement lends itself, as a rule to the installation of apparatus requiring solid foundations,the capacious living rooms, with their large window space, are admirably adapted for laboratories, and where the house stands in grounds of its own, facilities can be provided for physical recreation. There is much to be said for making the conditions under which research is carried out as congenial as possible.

"The associations with small incomes at their command cannot aspire to separate headquarters and, in such cases, accommodation has been sought at university or other public institutions, where equipped laboratories are leased at a rent which includes the provision of gas, electricity and water. With a modest income this course is far wiser than more ambitious projects which may result in "Overbuilding." The cost of upkeep of the headquarters is a first charge on the resources of the association and, as time goes on, it does not diminish: as a result, the essential research work may suffer. There is a natural temptation to acquire what appears at first sight to be a bargain in the estate market, but a home which entails an undue amount of expense in the future is no more a bargain to a corporate body than it is to the private individual."

Nature of Research Undertaken by Associations

"In previous reports we have directed attention to the nature of the work undertaken by associations and have laid some stress on the importance of fundamental research as compared with work directed to the removal of immediate and practical difficulties. We hold the view that it is no part of the function of an association to undertake work which normally falls to the consulting chemist or physicist, or to the consultant called in to advise on difficulties in connection with a works 'lay out.' On the other hand, an association, especially in its early years when the confidence and support of the industry are being enlisted, may well feel disposed to allow its staff to undertake subsidiary investigations requiring great experience and knowledge for their completion, although they are not of the widest application. The staffs of several associations have successfully coped with difficulties of this kind and as a result have gained immediately the confidence and trust of their members. But these efforts have rightly been regarded as a secondary function and have not been conducted to the exclusion of the larger issues. These can only be solved by getting down to fundamentals.

"There is indeed little basic difference between the fundamental research work required by industry and academic scientific research sometimes styled 'pure' research.

The real difference is one of stimulus. The general tendency in 'pure' research is to follow the train of thought of greatest scientific interest by pursuing the problem initially selected through all the ramifications which may present themselves, or at least through all those which interest the investigator. The phenomena investigated and the taste of the research worker are, in most cases, the only directive forces. In industrial research, on the other hand, the aim is more definitely objective; the work has a distinct purpose in view which the investigator must bear in mind constantly. He cannot afford to follow attractive by-paths unless he believes they will lead him to a relevant destination.

"The problems of industry draw attention to gaps in scientific knowledge which it is essentially the duty of the industrial researcher to fill. The acquisition of such knowledge may be called fundamental research as applied to industry for, without it, far-reaching changes and improvements in industry are almost impossible. Thus it is that the British Cotton Industry Research Association finds it necessary to study the properties of single cotton fibres and the chemical constitution of the cellulose molecule. The British Photographic Research Association is occupied in investigating the fundamental properties of silver haloids and the physico-chemical properties of gelatin and similar colloids. The British Portland Cement Research Association is endeavoring to ascertain the exact chemical nature of the compounds constituting Portland Cement. It was only by an elaborate investigation of the primary phenomena of abrasion and polishing that the British Scientific Instrument Research Association was able to perfect the abrasives and polishing powders which are now proving of such industrial importance. In all such cases the research worker has ever before his mind the necessity of bringing his investigation to a practical issue.

"We have been led to make observations because we have found some evidence recently of a good deal of misconception in the distinction popularly drawn between 'industrial' and 'pure' research. There is undoubtedly some ground for this attitude in the loose use by industrialists and company promoters of the word 'research' to describe experiment by trial and error and in the attempts often made to solve complex industrial problems on the full scale without any adequate preparation for the passage from the laboratory to works production. The wise manufacturer knows better than this and the man of science supports him. But we maintain that the distinction between fundamental industrial research and 'pure' research lies primarily in the source from which the impulse to its conduct is derived. We desire rather to emphasise the essential unity of all genuine research; its stimulus may come from different sources; its applications may be various; but its outlook, its spirit, its methods are one."

DR. S. W. STRATTON RESIGNS FROM DIRECTORSHIP

Becomes President of Massachusetts Institute of Technology

With the resignation of Dr. Stratton as director of the Bureau of Standards, the American Ceramic Society undoubtedly loses its best and most influential friend in the scientific departments of the government. As head of the only government Bureau which has had a regular appropriation for ceramic investigations over a period of years, he has shown such an insight into and appreciation of the needs of the ceramic industry that all who have gone to him personally with problems have come away feeling that he understood the question and would keep in direct contact with it.

The Bureau of Standards secured its first fund for ceramic investigation in 1910, when the Technologic Branch of the Geological Survey was merged into it. The amount appropriated was a mere pittance—it would not now pay the annual gas bill which the

Bureau incurs in its investigations. Dr. Stratton, by his insistent efforts with Congress, has been able to impress it with the urgent need of more funds, so that by the end of the war the amounts available for the work at the Bureau amounted to about $70,000 annually. By his continued efforts since then, he has prevailed upon Congress not to curtail this fund, even though it was very materially reducing appropriations to all Bureaus annually. Dr. Stratton knew from personal contact that now especially was the need for more funds, even more so than at any other time in the history of the industry, if the lead held in so many lines during the war were to be maintained.

S. W. Stratton

During the past four years he was able to obtain practically a new plant for the Ceramic Division. The old cramped, totally inadequate quarters in Pittsburgh were abandoned and several suites of rooms on three floors in a new structure were especially designed and equipped with the most up to date equipment. In the new quarters at Washington the space devoted to kilns and furnaces alone exceeds the entire space available at Pittsburgh before the war. With the removal of the plant to Washington the employees felt the enthusiasm and interest of Dr. Stratton in their work more than ever, as evidenced to them through his almost daily visits to the laboratory when not out of the city. This he did although the Ceramic Division was but one of eleven divisions and occupied part of one of seven large buildings, for all of which Dr. Stratton has secured appropriations from Congress.

The best wishes of his many friends in the American Ceramic Society go with him to his new duties as President of the Massachusetts Institute of Technology. We believe he will carry on his interest in the ceramic industry, for his close contacts cannot be broken off abruptly. What event could betoken more for the development of the technical side of the ceramic industry than to hear that a well-designed course in ceramic engineering would be inaugurated at that institution as a result of his connection there? In any case those who may take their ceramic problems to the newly established Research department of M.I.T. in the future will know that its president realizes the importance of the problem and will be exerting himself anew in a field in which he is already well acquainted.

U. S. BUREAU OF STANDARDS PURSUES ENAMEL INVESTIGATION

Some preliminary tests have been conducted by the Bureau of Standards in a study of the causes of specking of ground coat enamels. This specking appears as spots of oxide and slag in the enamel coating, a condition which appears to be due to excessive local rusting of the steel previous to the firing of the enamel.

Preliminary tests have been made on steel cups furnished by a manufacturer of such articles and coated with regular stock enamels. The results of the test indicate that the rusting and subsequent specking are due to an excess of acid or salts in the enamel. The defect has been remedied by the addition of sufficient sodium hydroxide

to the enamel previous to the dipping operation. Since this defect is a serious one in the production of white enamel ware, it will probably be advisable to continue this investigation in order to go into the subject more thoroughly.

G. A. BOLE IS MADE SUPERINTENDENT OF CERAMIC EXPERIMENT STATION

Mr. G. A. Bole has been appointed Superintendent of the Ceramic Experiment Station, U. S. Bureau of Mines, at Columbus, Ohio, to succeed Mr. R. T. Stull who was advanced to the position of Supervising Ceramist last April.

Mr. Bole has efficiently served as Acting Superintendent for six months prior to his appointment as Superintendent. He came to the Bureau in August 1921 from the New York State School of Ceramics, at Alfred, New York, where he was for nine years head of the department of chemistry. Under his supervision were developed strong courses in physical chemistry as applied to ceramics, as well as courses in industrial fuels which included heat balances on power plants and ceramic kilns.

His work since coming to the Bureau has consisted principally of control work in connection with the industrial kiln investigation. Together with Mr. F. G. Jackson, he has been studying the oxidation of ceramic ware during firing.

The Bureau is at present carrying on industrial coöperative work with more than a dozen industrial concerns, as well as maintaining an efficient laboratory staff and laboratory car.

G. A. Bole

Mr. Ellsworth Ogden has been appointed ceramic engineer with the U. S. Bureau of Mines. Mr. Ogden's work will consist largely of field work. He comes to the Bureau with a wealth of ceramic engineering experience. Mr. Ogden's appointment was made upon the recommendation of Colonel Orton, Mr. Bleininger, and Mr. Purdy.

REPORTS OF INVESTIGATIONS BUREAU OF MINES

Production of Alumina from Clay Tests on the Miguet Process

By Clyde E. Williams (Metallurgist and Superintendent, Northwest Experiment Station, Bureau of Mines), and Clarence E. Simms (Electrometallurgist, Bureau of Mines)

In recent years much interest has been centered on the possibility of producing alumina from clay, and proposed methods for the recovery of alumina are appearing constantly in parent literature. As a good grade of clay contains from 30 to 40 per cent of alumina, the prospect of recovering it is alluring, although obviously difficult.

A patent typical of many projected thermal processes is that of Paul Miguet (U. S. Patent No. 1,376,563) entitled "Process for the preparation of pure alkaline aluminates."

He proposes to prepare alkaline aluminate by fusing clay, lime, and scrap iron with a reducing agent in the electric furnace thereby reducing the silica and forming calcium aluminate and ferrosilicon. The calcium aluminate, being lighter, would float on top substantially free from foreign oxides. It could then be tapped off, cooled, and later crushed and leached with sodium carbonate solution to form, by double decomposition: sodium aluminate, and calcium carbonate. The former is soluble and yields readily aluminum hydroxide. The ferrosilicon would be recovered as such and sold at a profit. The reactions are supposedly as follows:

(1) $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O + Fe + 4C + CaO - FeSi_2 + 4CO + CaO \cdot Al_2O_3 + 2H_2O$.

(2) $CaO \cdot Al_2O_3 + Na_2CO_3 - CaCO_3 + Na_2O \cdot Al_2O_3$.

So many reactions similar to the above have been proposed, and it is so popularly believed that alumina can be obtained from clay by fusion, that the Northwest experiment station of the Bureau of Mines at Seattle, Wash., undertook to investigate the Miguet process.

The tests were carried out in a carbon-lined pit furnace of the Girod type having a tap hole to remove the fused material. Clay containing 38 per cent alumina pure air-slaked lime, steel turnings, and gas-retort carbon were used. These materials were finely ground, intimately mixed, wetted, and dried in lumps to avoid dust.

In the first tests the charges were made up with clay, lime, iron, and carbon in theoretical proportions according to the Miguet patent. The charge melted down readily and when melted was tapped. The analysis showed only a slight reduction of silica, and it was thought that possibly insufficient time had been allowed for reduction. The test was therefore repeated, the charge being held molten for a considerable time before tapping. No increase was noted in the amount of silica reduced. When the product was crushed and leached with a hot concentrated solution of sodium carbonate, only a trace of alumina and fully as much ferrous iron was found in solution.

When the proportion of lime was increased, it merely increased the melting point and gave no better product. In these first tests an effort was made to keep within the limits of commercial practicability, but having failed to obtain any favorable results, these restrictions were cast aside and tests were made to determine what was technically possible. The proportion of lime, carbon, and iron to clay was increased to speed up their action on the clay, and the charge after fusion was heated to 1800°C and held for 30 minutes. Still results were unsatisfactory. A charge was then made up with carbon three times and iron twice the theoretical quantity. The purpose was to subject the charge to the most intense reducing conditions possible, and silica is known to reduce more readily in the presence of iron. The charge was melted with the furnace over-powered to such an extent that dense fumes arose. The production obtained was black and stony—hard enough to scratch glass easily. On examination, it was found to contain carbides of calcium, aluminum, and silicon, sillimanite, and quantities of a glassy substance. The analysis showed that about 40 per cent of the silicon had been reduced and alloyed with the iron. The product of this final fusion, when leached with sodium carbonate, gave a recovery of about 30 per cent of the alumina. This alumina produced contained 0.6 per cent SiO_2.

The fact that alumina was actually produced gives some small basis for the claims of the patent, but the prospects of its successful applications are extremely poor. In the first place, to produce alumina by the method of the most favorable test, the cost of the material alone would be more than $300 per ton, as the minimum figure. Moreover, there is no proof that calcium aluminate was formed, because, with so much carbide present, it is just as likely that the sodium aluminate obtained was formed by the decomposition of aluminum carbide and its subsequent solution in the sodium carbonate.

It is certain, too, that silica is not alone in being acted on by the carbon, but that all the other oxides will also be reduced in varying degrees.—*Reports of Investigations, U. S. Bureau of Mines.*

U. S. BUREAU OF MINES CONSULTANT

Mr. W. D. Richardson has accepted an appointment as consultant with the Ceramic Experiment Station, United States Bureau of Mines, Columbus, Ohio. His services are to be utilized in connection with the industrial kiln investigations being carried out by the Bureau.

Mr. Richardson was graduated from Colgate University with the degree of A.B. in 1879 and received his A.M. degree in 1884. Until 1887 he was located with the Columbia School of Mines and for two years he assisted in the chemical laboratory of Dr. Thomas O'Connor Sloane. Three years more were spent in Minnesota manufacturing face brick, then after a short time in St. Louis he located in Ohio. Since that time Mr. Richardson has been managing brick plants and engaged in general consulting practice, designing and building plants. He is best known as a designer of kilns. He was President of the American Ceramic Society in 1906–1907 and continues as a contributor to the technical literature on kilns and kiln burning.

CALENDAR OF CONVENTIONS

American Association of Ice & Refrigeration—Washington, D. C., Probably March 1923.
American Association of Museums—Charleston, S. C., May, 1923.
AMERICAN CERAMIC SOCIETY—Pittsburgh, Pa., Feb. 12–16, 1923.
American Concrete Institute—Cincinnati, Ohio, Jan. 22–25, 1923.
American Engineering Standards Comm.—29 W. 39th St., New York City, Dec. 14, 1922.
American Face Brick Association—West Baden, Ind., Dec. 5–7, 1922.
American Foundrymen's Association—Date not determined.
American Institute of Mining and Metallurgical Engineers—New York City, Feb. 19–22, 1923.
American Malleable Castings Assn.—Cleveland, Ohio, Jan. 9–10, 1923.
American Metric Association—Boston, Mass., Dec. 30, 1922.
American Society of Mechanical Engineers—New York City, Dec. 4–8, 1922.
American Society of Refrigerating Engrs.—New York City, Dec. 4–6, 1922.
American Society for Testing Materials—Place not determined, June 1, 1923.
American Zinc Institute—St. Louis, Mo. or Atlantic City, N. J., First or second Monday in May, 1923.
Association of Scientific Apparatus Makers of the United States of America—Bureau of Standards, Washington, D. C., April 20, 1923.
Canadian National Clay Products Association and Western Ontario Clay Workers Association—Hamilton, Ont., January 24–26, 1923.
Chamber of Commerce of the U. S. A.—Place not determined, Week of May 7, 1923.
International Chamber of Commerce—Rome, Italy, Week of March 19, 1923.
Clay Products Association—Chicago, Ill., Third Tuesday each month.
Common Brick Mfrs. Association of America—Cleveland, Ohio, Week of Feb. 5, 1923.
Dental Manufacturers Club—St. Louis, Mo., November 20, 1922.
Dental Exhibit of the Dental Manufacturers Club—St. Louis, Mo., November 21–24, 1922.

Federated American Engineering Societies—Place not determined, Date not determined.

Manufacturing Chemists Association—New York City, June, 1923.

Mining and Metallurgical Society of America—New York City, December 7–13, 1922.

National Association of Mfrs. of Pressed & Blown Glassware—Pittsburgh, Pa., March 13, 1923.

National Association of Mfrs. of U. S.—New York City, Week of May 14, 1923.

National Association of Stove Mfrs.—Richmond, Va., May 9, 1923.

National Association of Window Glass Mfrs.—Place not determined, Date not determined.

National Association Builders Board of Control—Des Moines, Iowa, February 1923.

National Bottle Mfrs. Association—Atlantic City, N. J., Last of April, 1923.

National Brick Mfrs. Association—Cleveland Ohio, Week of Feb. 5, 1923.

National Canners Association—Atlantic City, N. J., Week of Jan. 22, 1923.

National Exposition of Power and Mechanical Engineering—New York City, December 7–13, 1922.

National Gas Association of America—Loiusville, Ky., Spring, 1923.

National Jewelers Board of Trade—New York City, January 18, 1923.

National Paving Brick Mfrs. Assn.—Place not determined, Date not determined.

National Society for Vocational Education—Detroit, Mich., November 30–December 2, 1922.

Portland Cement Association—Chicago, Ill., November 20–22, 1922.

Refractories Manufacturers Assn.—White Sulphur Springs, W. Va., Nov. 2–3.

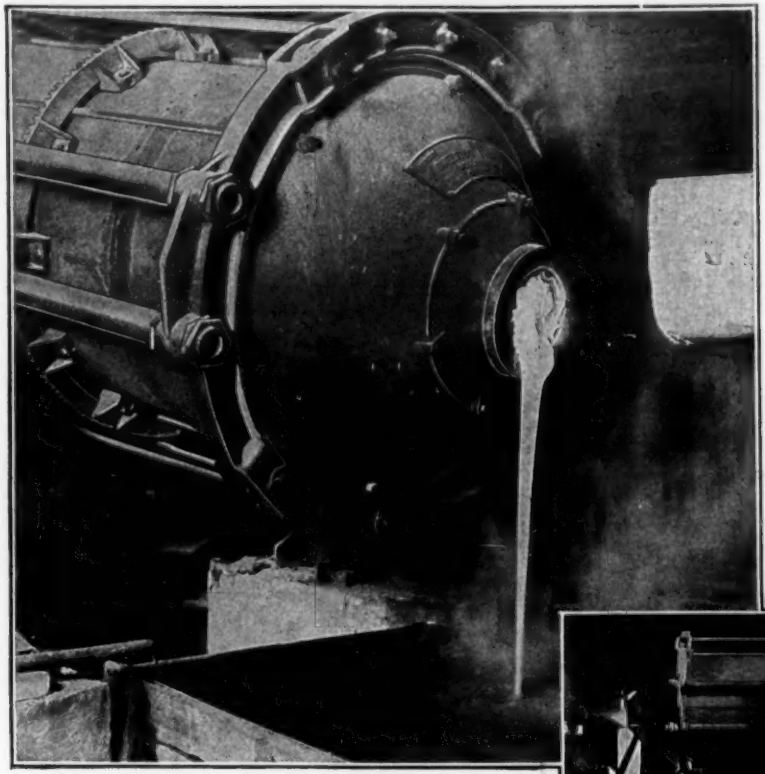
Sanitary Potters Association—Pittsburgh, Pa., Monthly Meetings.

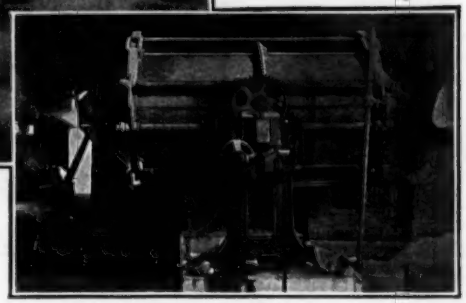
Stoker Mfrs. Association—Hot Springs, Va., November 21–23, 1922 (fall meeting) May or June, 1923 (annual). Place not determined.

Taylor Society—New York City, November 23–25, 1922.

Tile Manufacturers Credit Assn.—Beaver Falls, Pa., Quarterly Meetings.

U. S. Potters Association—Probably Washington, D. C., December 10, 1922.





These illustrations made from photographs taken in the plant of Ingram-Richardson Mfg. Co., Beaver Falls, Pa.

12-21

"Our U. S. Enamel Furnaces Increase Output 25% per day at a Saving of 50% in Fuel Cost."

Ingram-Richardson Mfg. Company claim those remarkable results for their U. S. Enamel Furnaces. With four U. S. Furnaces operating at their plants at Frankfort, Indiana, and Beaver Falls, Pa., they are saving thousands of dollars yearly in fuel and labor.

Their white and colored enamels are smelted in quick time, with low loss. The work is easy and sure. The Furnace is under perfect scientific control. The melting process is visible. The Furnace rotates while melting and tilts when pouring. Linings last longer and cost less.

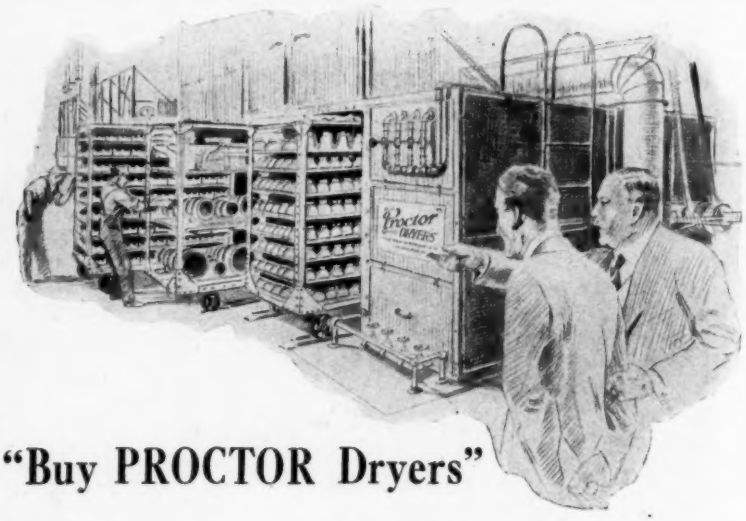
The U. S. Enamel Furnace is saving money over the old brick smelter in the Ingram-Richardson Mfg. Company plant. It will do the same for you.

Let the U. S. Furnace melt your enamel.

Write for specifications and prices on 60 lb., 150 lb., 400 lb., 750 lb., and 1200 lb. Enamel Furnaces. We will send photographs and list of users where furnaces are in operation.

THE
U. S. SMELTING FURNACE CO.
BELLEVILLE, ILLINOIS

(When writing to advertisers, please mention the JOURNAL)



"Buy PROCTOR Dryers"

"These machines are giving perfect drying on all types of porcelain—

"It's really surprising what improvement they've made over our old dry-rooms. The time they save is directly responsible for a much quicker production-turnover. For instance, our 80 lb. to 120 lb. insulators used to take 13 to 14 days to dry—now they're dried in 48 to 60 hours.

"Our loss used to run as high as 15%—now it's down to 3% or 4% because of correct drying.

"We now use only about half the floor-space, fewer workmen and greatly less steam—that's saving money.

"But what is best of all, our drying is systematic and smooth-running; the kilns are never kept waiting; we wouldn't be without PROCTOR DRYERS."

This is a typical experience with PROCTOR DRYERS. Let us acquaint you with their profitable advantages in drying any Ceramic Product.

"Proctor" DRYERS

PROCTOR & SCHWARTZ, INC.
PHILADELPHIA, PA.

BUYERS' GUIDE

Air Compressors
General Electric Co.

Alumina (Hydrate and Calcined)
Pennsylvania Salt Mfg. Co.

Auger Machines
Chambers Brothers Co.
Manufacturers Equipment Co.

Automatic Cutters
Chambers Brothers Co.

Automatic Stove Rooms
Philadelphia Drying Mch. Co.

Ball Mills
Hardinge Co.
Mueller Machine Co., Inc.

Bituminous Coal
Seaboard Fuel Corp.

Boilers
Nashville Industrial Corp.

Brick Making Machinery
Chambers Brothers Co.

Caustic Soda
Pennsylvania Salt Mfg. Co.

Ceramic Chemicals
Drakenfeld Co., B. F.
Harshaw, Fuller and Goodwin Co.
Paper Makers Importing Co., (Inc.)
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Ceramic Plant Equipment
Chambers Brothers Co.
Manufacturers Equipment Co.
Mueller Machine Co., Inc.
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.

Clay (Abrasives)
Old Hickory Clay & Talc Co.

Clay (Ball)
Old Hickory Clay & TalcCo.
Potters Supply Co., The

Clay (China)
Edgar Brothers Co.
Drakenfeld and Co., B. F.
Old Hickory Clay & Talc Co.
Paper Makers Importing Co., (Inc.)
Roessler & Hasslacher Chemical Co.

Clay (Electrical —Porcelain)
Edgar Brothers Co
Old Hickory Clay & Talc Co.
Paper Makers Importing Co., (Inc.)

Clay (Enamel)
Edgar Brothers Co.
Old Hickory Clay & Talc Co.
The Vitro Manufacturing Co.

Clay (Fire)
Edgar Brothers Co.
Old Hickory Clay & Talc Co.
Paper Makers Importing Co., (Inc.)

Clay (Potters)
Old Hickory Clay & Talc Co.

Clay (Sagger)
Edgar Brothers Co.
Old Hickory Clay & Talc Co.
Paper Makers Importing Co., (Inc.)
Potters Supply Co., The

Clay Handling Machinery
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.
Mueller Machine Co., Inc.

Clay Miners
Edgar Brothers Co.
Old Hickory Clay & Talc Co.

Clay (Wall Tile)
Old Hickory Clay & Talc Co.

Clay Washing Machinery
Mueller Machine Co., Inc.

Clay Working Machinery
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.
Mueller Machine Co., Inc.

Coal-(Bituminous)—
Seaboard Fuel Corp.

Colors
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co
Vitro Mfg. Co.
Wuerz, Eugene

Conditioning Machinery
Philadelphia Drying Machinery Co.

Conical Mills
Hardinge Co.

Controllers
General Electric Co.

Conveyors (Clay, Sand, Brick, etc.)
Hadfield-Penfield Steel Co.
Philadelphia Drying Machinery Co.
Manufacturers Equipment Co.
Mueller Machine Co., Inc.

Controllers (Automatic Temperatures)
Charles Engelhard, Inc.

Cornwall Stone
Pennsylvania Pulverizing Co.

Crushers
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Hardinge Co.
Manufacturers Equipment Co.
Mueller Machine Co., Inc.

Decorating Supplies
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Disintegrators
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.
Mueller Machine Co., Inc.

Doors (Kiln-Dryer)
Manufacturers Equipment Co.

Dryers (China Ware—Porcelain)
Philadelphia Drying Machinery Co
Proctor and Schwartz, Inc.
Russell Engineering Co.

Dryers (Radiated Heat)
Manufacturers Equipment Co.

Drying Machinery
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.
Manufacturers Equipment Co.

Electrical Instruments
Brown Instrument Co.
Charles Engelhard
Wilson-Maeulen Co.

Electrical Porcelain Machinery
Mueller Machine Co., Inc.

Enameling Equipment, Complete
Chicago Vitreous Enamel Products Co.
The Porcelain Enamel & Mfg. Co

Enameling Furnaces
Chicago Vitreous Enamel Products Co.
General Electric Co.
The Porcelain Enamel & Mfg. Co
U. S. Smelting Furnace Co.

Enameling Furnaces (Electric)
General Electric Co.

Enameling Muffles
General Electric Co.
Parker-Russell Mining & Mfg. Co

Enameling, Practical Service
Chicago Vitreous Enamel Products Co.
The Porcelain Enamel & Mfg. Co

Feldspar and Flint
Ground to
98% passing 200 mesh
91% passing 300 mesh

Grinding Feldspar to a fineness of less than 2% on 200 mesh is no unusual record, but when it is realized that the Hardinge System produces such a product and at the same time is continuous in operation, delivering a uniformly fine product, no wonder these results are remarkable and indicate a marked advance in the art of pulverizing.

Hardinge Company, Incorporated,
120 Broadway, New York, N. Y.

Hardinge Conical Mills

BUYERS' GUIDE (continued)

Enamels, Porcelain
Chicago Vitreous Enamel Products Co.
The Porcelain Enamel & Mfg. Co.
The Vitro Manufacturing Co.

Engineering Service
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.

Equipment (Electrical)
General Electric Co.

Equipment (used)
Nashville Industrial
Mueller Machine Co., Inc.
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.
Russell Engineering Co.

Engines
Nashville Industrial Corp.

Extruding Machines (Lab. Use)
Chambers Brothers Co.

Feldspar
Drakenfeld and Co., B. F.
Golding-Keene Co.
Harshaw, Fuller and Goodwin Co.
O'Brien and Fowler
Old Hickory Clay & Talc Co.
Pennsylvania Pulverizing Co.
Roessler & Hasslacher Chemical Co.

Filtering Machinery
Mueller Machine Co., Inc.

Fire Brick
Parker-Russell Mining & Mfg. Co.

Flint
Golding-Keene Co.
Pennsylvania Pulverizing Co.

Fuel
Seaboard Fuel Corp.

Furnaces
Chicago Vitreous Enamel Co.
Parker-Russell Mining & Mfg. Co.
The Porcelain Enamel & Mfg. Co.
The Surface Combustion Co.
U. S. Smelting Furnace Co.

Furnaces (Electrical)
General Electric Co.

Glazes and Enamels
Chicago Vitreous Enamel Co.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Manufacturing Co.

Gold
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.

Impervite (Refractory and Hard Porcelain)
Charles Engelhard, Inc.

Iron (Enameling)
United Alloy Steel Corp.

Jiggers
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

Kaolin
Edgar Plastic Kaolin Co.
Harshaw, Fuller and Goodwin Co.
Old Hickory Clay & Talc Co.
Roessler & Hasslacher Chemical Co.

Kryolith
Pennsylvania Salt Mfg. Co.

Laboratory Equipment
Nashville Industrial Corp.

Metals (Porcelain Enameling)
United Alloy Steel Corp.

Mills (*See under Ball Mills*)
(*See under Pebble Mills*)

Minerals
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
The Vitro Manufacturing Co.

Mixing Machines
Chambers Brothers Co.

Muriatic Acid
Harshaw, Fuller and Goodwin Co.
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.

Operators (Coal)
Seaboard Fuel Corp.

Oxides
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Paper Makers Importing Co., (Inc.)
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.
The Vitro Manufacturing Co.

Pans (Wet and Dry)
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.
Mueller Machine Co., Inc.

Paris White
Potters Supply Co., The

Pebble Mills
Hadfield-Penfield Steel Co.
Hardinge Co.
Mueller Machine Co., Inc.

Pins
Potters Supply Co., The

Placing Sand
Pennsylvania Pulverizing Co.

Plate Feeders
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.

Porcelain Enameling Service, Practical
Chicago Vitreous Enamel Co.
The Porcelain Enamel & Mfg. Co.

Porcelain Enamels
Chicago Vitreous Enamel Co.
The Porcelain Enamel & Mfg. Co.
The Vitro Manufacturing Co.

Pottery Machinery
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.
Mueller Machine Co., Inc.

Producer Gas Burning Systems
Manufacturers Equipment Co.

Pug Mills
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.

Pulverizing Machinery
Hadfield-Penfield Steel Co.
Hardinge Co.
Manufacturers Equipment Co.
Mueller Machine Co., Inc.

Pulverizing Mills
Hadfield-Penfield Steel Co.
Hardinge Co.
Mueller Machine Co., Inc.

Pumps
Mueller Machine Co., Inc.

Pyrometers (Indicating)
Brown Instrument Co.
Charles Engelhard, Inc.
Wilson-Maeulen Co., Inc.

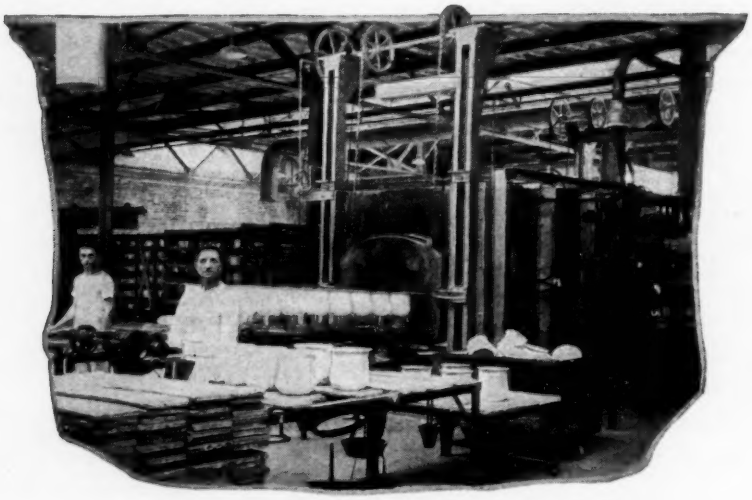
Pyrometers (Recording)
Brown Instrument Co.
Charles Engelhard, Inc.
Wilson-Maeulen Co., Inc.

Pyrometer Tubes (Refractory and Hard Porcelain)
Brown Instrument Co.
Charles Engelhard, Inc.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co

Quartz
Old Hickory Clay & Talc Co.

Recording Instruments
Brown Instrument Co.
Charles Engelhard, Inc.
Wilson-Maeulen Co., Inc.

Now it's done electrically



Vitreous enameling has been simplified and improved by the use of electric furnaces equipped with heating units of G-E Direct-Heat design.

Unmuffled units within the furnace chamber radiate smokeless, flameless heat direct to the charge—with an intensity so perfectly applied and accurately controlled that the maximum speed and highest quality of vitreous enameling are obtained; and product spoilage is eliminated.

Vitreous enameling can be done by electric heat at less cost than with any other type of furnace. Our Heating Specialists are at your service.

General Electric Company

General Office Schenectady, N.Y.

Sales Offices in all large cities

39-82

(When writing to advertisers, please mention the JOURNAL)

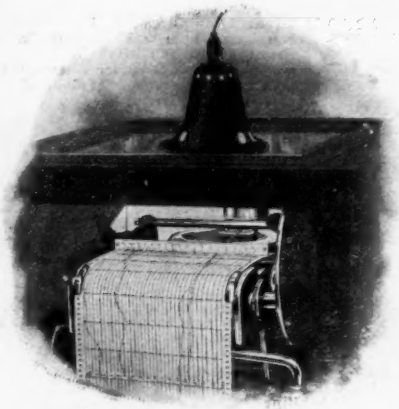
BUYERS' GUIDE (continued)

Refractory Materials
Parker-Russell Mining & Mfg. Co.
Regulators (Automatic Temperatures)
Brown Instrument Co.
Charles Engelhard, Inc.
Wilson-Maeulen Co., Inc.
Sagger Presses
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.
Shippers (Coal)
Seaboard Fuel Corp.
Silica Brick
Parker-Russell Mining & Mfg. Co.
Silex Lining
Hardinge Co.
Selenite of Sodium
Drakenfeld and Co., B. F.
Vitro Mfg. Co.
Smelters
Parker-Russell Mining & Mfg. Co.
The Surface Combustion Co.
U. S. Smelting Furnace Co.
Spar
Golding-Keene Co.
Pennsylvania Pulverizing Co.
Stilts
Potters Supply Co., The
Stoneware (Chemical)
Nashville Industrial Corporation
Sulphuric Acid
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.
Temperature Instruments (Measuring)
Charles Engelhard, Inc.
Wilson-Maeulen Co., Inc.
Thermometers (Electric Resistance)
Charles Engelhard
Wilson-Maeulen Co., Inc.
Tile Machinery (Floor and Wall)
Mueller Machine Co., Inc.
Tubes (Insulating)
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.
Tubes (Pyrometer)
Brown Instrument Co.
Charles Engelhard, Inc.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.
Tunnel Kilns
Russell Engineering Co.
Vacuum Pumps
Mueller Machine Co., Inc.
Whiting
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Zirconia
Vitro Mfg. Co.

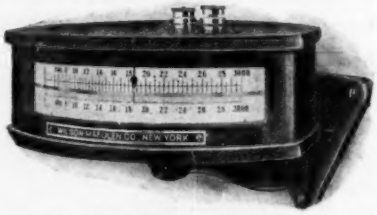
ALPHABETICAL LIST TO ADVERTISERS

	Page
Brown Instrument Co.	21
Chambers Brothers Co.	16
Chicago Enamel Product Co., The	17
Drakenfeld and Co., B. F	11
Dominion Feldspar Corporation	13
Edgar Brothers Co.	16
Engelhard, Charles Inc.	14
General Electric Co.	8
Golding-Keene Co.	12
Hadfield-Penfield Steel Co.	13
Hardinge Co.	6
Harshaw, Fuller and Goodwin Co.	2
Journal of the Society of Glass Technology	16
McDanel Refractory Porcelain Co.	12
Manufacturers Equipment Co.	15
Montgomery Porcelain Products Co.	—
Mueller Machine Co., Inc.	22
Nashville Industrial Corporation	14
O'Brien and Fowler	12
Old Hickory Clay & Talc Co.	14
Paper Makers Importing Co., (Inc.)	Inside back cover
Parker-Russell Mining & Mfg. Co.	10
Pennsylvania Pulverizing Co.	20
Pennsylvania Salt Mfg. Co.	22
Philadelphia Drying Machinery Co.	1
Porcelain Enamel & Mfg. Co.,	Back cover
Potters Supply Co., The	16
Proctor and Schwartz, Inc.	4
Roessler and Hasslacher Chemical Co.	Inside front cover
Russell Engineering Co.	20
Seaboard Fuel Corporation	19
Surface Combustion Co.	12
United Alloy Steel Corp.	13
U. S. Smelting Furnace Co.	3
Vitro Manufacturing Co.	15
Wilson-Maeulen Co., Inc.	10

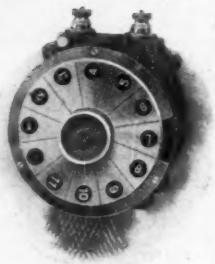
(When writing to advertisers, please mention the JOURNAL)



TAPALOG (Multi-Recorder)



The
TRUEST
Combination
of
Accuracy
Durability
Robustness
Convenience



PYROMETERS for Production or Research

Wilson-Maeulen Co., Inc. 386 Concord Ave., New York

5-22

COAL, COKE, GAS, OIL FIRED

ENAMELING MUFFLES
SMELTERS
INDUSTRIAL FURNACES

DESIGNERS AND BUILDERS
HIGH GRADE FIRE BRICK, SPECIAL TILE
SILICA BRICK AND TILE, ETC.

YOUR INQUIRIES WILL RECEIVE PROMPT ATTENTION

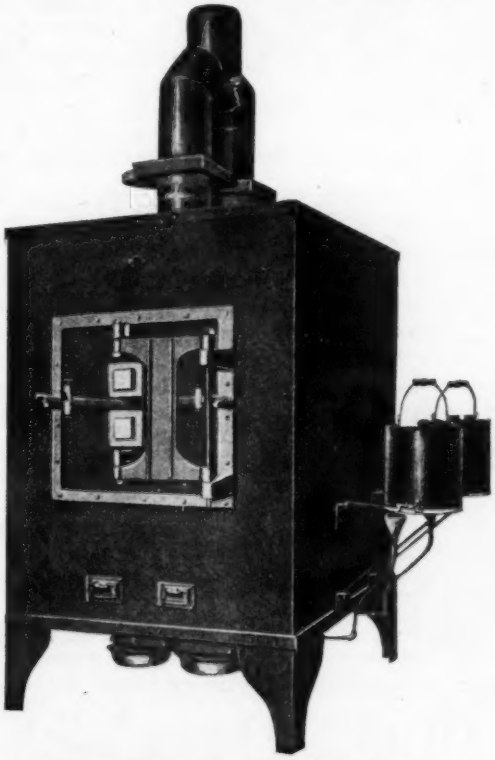
THE PARKER RUSSELL
MINING AND MANUFACTURING CO.
ST. LOUIS, MO. 603 LACLÈDE GAS BUILDING

PERFECTION POTTERY KILNS

FOR FIRING BISCUIT, CLAY BODIES AND GLAZES

EQUIPPED FOR KEROSENE OIL

MANUFACTURED GAS OR NATURAL GAS



NO. 12 PERFECTION POTTERY KILN
Equipped with Kerosene Oil Burners

B. F. DRAKENFELD & CO., Inc.

50 MURRAY STREET NEW YORK, N. Y.

ILLUSTRATED CATALOG MAILED ON REQUEST

VITREOUS ENAMELING FURNACES

Utilizing Clark patented principle of intermittent and direct firing
(The Surface Combustion Co.—Sole Licensee)

16 MONTHS WITHOUT REPAIRS
AND GOOD FOR SEVERAL YEARS MORE

Unretouched photograph of interior of Surface Combustion Enameling Furnace in operation 6 days per week for 16 months with no repairs whatever.

Write now for full details and engineering data.

Branch Offices:
Chicago
Philadelphia
Pittsburgh
Baltimore

THE SURFACE COMBUSTION CO.
Engineers & Manufacturers of Industrial Furnaces for all purposes

Main Offices and Works:
Gerard Ave. & 145th St.
Bronx, N. Y. C.

5-22

TRADE MARK

Pyrometer Tubes—Protection Tubes—Combustion Tubes
McDanel Refractory Porcelain Company
Beaver Falls, Pennsylvania

UNUSUAL · SHAPES · OUR · SPECIALTY ·

The GOLDING-KEENE CO.
Plant at Keene, N. H.

FELDSPAR

The Finest Spar for The Finest Ware.

Charles E. Golding, President — J. Alfred Dennis, Manager.

Crude "Derry" Spar

Sold direct to millers or to potters who grind

O'BRIEN & FOWLER
114 Wellington Street,
Ottawa.

Quarry: Buckingham, Que.

FELDSPAR

PAR EXCELLENCE

from

CANADA

UNIFORMITY—QUALITY—SUPPLY

All assured for years to come to users of the famous "DERRY" spar from the celebrated O'Brien & Fowler mine at Buckingham, Quebec, Canada.

EVERY CARLOAD GUARANTEED

Samples and analysis gladly submitted on request

Address all correspondence to

DOMINION FELDSPAR CORPORATION

ROCHESTER **NEW YORK**

For Fine Porcelain Enamel

Toncan Metal used as a base for porcelain enameling insures a lasting, brilliant finish, free from blemish. Economical because it reduces waste. Ask for our book "Better Sheet Metal."

A BETTER IRON

TONCAN METAL

The United Alloy Steel Corporation, Canton, Ohio.

THE HADFIELD PENFIELD STEEL CO.

BUILT RIGHT RUN RIGHT

BUCYRUS OHIO

CLAY PLANT EQUIPMENT

We build every machine and appliance required for making various Clay Products. Correspondence solicited. We also build Rotary Driers, Cement Mchy., Fuel Oil Engines (Diesel Type), Gasoline Locomotives, Ship Deck Equipment, etc.

The Hadfield-Penfield Steel Co., Bucyrus, Ohio.

Formerly The American Clay Mchy. Co.

1-22

A WORD FROM THE MEMBERSHIP COMMITTEE.

EVERY MAN in the Ceramic field owes it to himself and to the industry to be a member of THE AMERICAN CERAMIC SOCIETY.

The growth of the Society shows its increasing importance. Membership means influence and prestige for every man affiliated.

The circulation of the "Journal" is keeping pace with the growth of the Society and the advertising is increasing as well. Every membership received means greater possibilities in its work.

For full information address—

O. O. BOWMAN, 2nd, Chairman Membership Committee — BOWMAN COAL CO. Trenton, N. J.

CHEMICAL WARE & MACHINERY

From the Old Hickory Powder Plant. An immense amount of new and slightly used chemical stoneware, Duriron, laboratory equipment, technical machinery, boilers, engines, etc., now available for immediate delivery at extremely low prices. Write for Bulletin No. 14.

NASHVILLE INDUSTRIAL CORPORATION, Jacksonville, Tenn.

1917 **Quality — Service — Reliability** 1922

The highest grade, superior quality, Ball and Sagger Clays for all purposes—Prices in line—Perfect Service—We mine and prepare our own clays. Try them and cut your plant costs.

Old Hickory Clay & Talc Co., Inc.

PADUCAH The company with the Clay and the Service Kentucky

A WORKING TOOL

More and more are the operating men in industry coming to realize the need of equipment for accurately and continuously indicating and recording temperature.

ENGELHARD PYROMETERS

are helping many in the ceramic industries. You will find that they give long accurate service with a surprisingly low maintenance cost.

That's why so many people say that

Engelhard Pyrometers Are Good Pyrometers to Standardize on

Charles Engelhard, Inc.

30 Church Street, Cat.—S-2. New York City

ZIRCONIA

Natural Dioxide

powdered——granulated

White Refined Dioxide

free from iron

ENAMELS IN ALL COLORS

For **CAST** Iron

Coloring Oxides

For **STEEL**

Vitro White

We Have Faith in Our Goods so We Advertise Here——

The Underwood Producer Gas System, patented, saves fuel and labor in burning clayware, baking carbon products, roasting ores, heating lehrs in glass factories, also revolving pots, etc., and enameling metal ware.

The Justice Radiated Heat and Waste Heat Dryers for drying structural clayware have no equal in economy and efficiency.

"Meco" Single Roll Rock and Shale Crushers, Elevators, conveyors, and feeders make up the most complete clay preparing outfit, a necessity in every clay plant when material must be ground and screened. Write us about these things. To answer is our pleasure.

THE MANUFACTURERS EQUIPMENT CO.

Dayton, Ohio, U. S. A.

9-22

Quality *Uniformity* *Experience*

Edgar QUALITY *Clays*

REALLY washed—Highest percentage clay substance

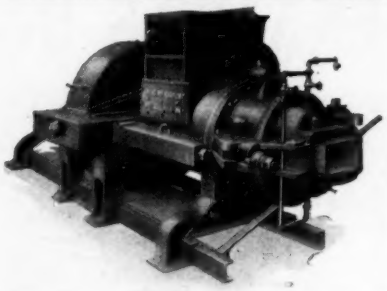
Brands	*Produced by*
Edgar Florida Kaolin	*Edgar Plastic Kaolin Co.*
Edgar Georgia Paper Clay and Kaolin	*Edgar Brothers Co.*
Lake County Florida Clay	*Lake County Clay Co.*

One Management—Office, Metuchen, N. J.

12-21

Brick Making Machines

Crushers Grinders Mixers
Automatic Cutters



Chambers Bros. Co.
Philadelphia Pa.

The Journal of the Society of Glass Technology

A quarterly Journal containing original papers and abstracts of papers covering the whole field of Glass Technology.

Annual Subscriptions to Society (including Journal)

Ordinary Members	$ 7.00
Collective Members	$15.00
Price per Number to non-Members	$2.50
Price per volume (unbound) to non-Members	$9.00

Forms of application for Membership may be obtained from the American Treasurer of the Society, Mr. Wm. M. Clark, Ph.B., Nela Park, Cleveland, Ohio.

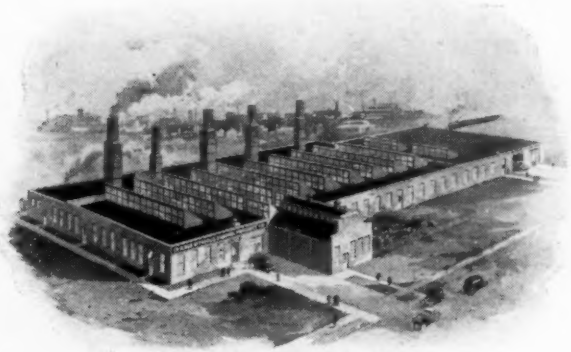
Address orders and inquiries to: The Secretary Society of Glass Technology, The University, Sheffield, England

WE manufacture Pins, Stilts, Saggers, Tile for Decorating Kilns.

WE handle the best grades of American Ball Clay, Sagger Clay, Wad Clay, Bitstone, Imported Paris White and Domestic Whiting.

For full information Address

The Potters Supply Co.
East Liverpool Ohio.



THE NEW
CHICAGO VITREOUS SPEED-FORK

(Patent Pending)

Saves thousands of dollars each year in giving almost continuous use of Enameling furnaces.

It is easy and positive in its operation and the labor and fuel savings are especially marked, as by the old method the men were idle while waiting for the load to burn and again the furnace was idle while the men unloaded and loaded the fork. With this new device the men are getting ready a load while another load is burning, thus the furnace is continuously in use except the time taken in pulling out a load and putting in another, being thirty seconds.

Full particulars cheerfully given.

We also handle the later improved furnaces installed together with full equipment for enameling plants.

CHICAGO VITREOUS ENAMEL PRODUCT CO.
1407-1447 So. 55th Court, Cicero, Ill.

LUSTERLITE ★ ENAMELS
CHICAGO VITREOUS ENAMEL PRODUCT CO.

Manufacturers of Higher Grade Porcelain Enamels for the enameling of Steel and Cast Iron (Wet Process)

CLASSIFIED ADVERTISING

Professional Services

This space will cost only $3.50 per issue.

Wanted—A long run of the Transactions of the American Ceramic Society, second-hand. State price and condition. Address "Box 27," American Ceramic Society, 211 Church Street, Easton, Pa.

Being an engineer will not guarantee employment of your services — You must tell what you have done and can do—Let those who need your services know about you and your ability.

Do you require help? Make your wants known by advertising here.

Ceramic Engineer—two years' experience in factory making electrical porcelain by casting method. Successful in reducing losses and costs. Desires position with company producing porcelain or other ceramic ware. Address "Box 17," American Ceramic Society, 211 Church St., Easton, Pa.

(When writing to advertisers, please mention the JOURNAL)

Are You Using the Right Kind of Coal for Kiln Firing?—

For many years it has been our pleasure in supplying the most discriminating Potteries in the East with—

High Grade Bituminous Coal

LOW ASH
SULPHUR
VOLATILE

Our Engineering Department will gladly go into details

SEABOARD FUEL CORPORATION
1610 Spruce St.
PHILADELPHIA, PENNA.

Russell Tunnel Kiln

Russell Tunnel Kilns are far beyond the experimental stage. A number are in daily operation in several industries, saving time, labor and fuel. The details will interest you. Write for them, and special catalog, "Modern Firing."

RUSSELL ENGINEERING COMPANY
Railway Exchange Bldg., St. Louis, Mo.

E–542

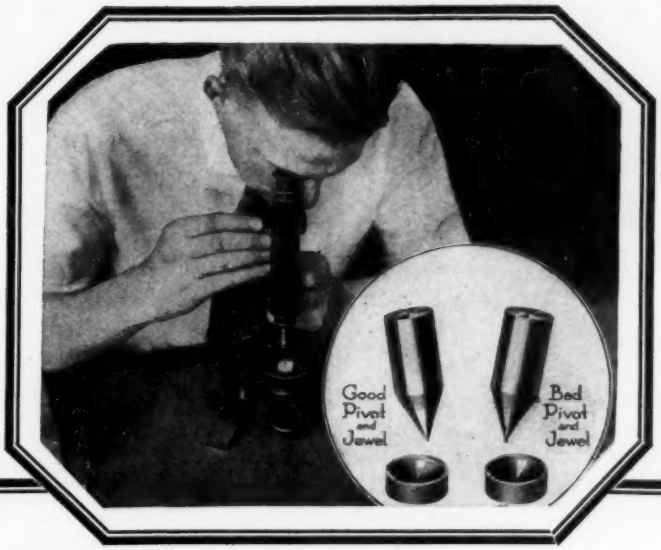
PENNSYLVANIA PULVERIZING CO.

LEWISTOWN, PENNA.

Pure Canadian Potash Feldspar

Potters Flint **Placing Sand**

SALES OFFICE
341 Fourth Avenue
Pittsburgh, Pa.



What's "Under the Hood"
of
Brown Pyrometers

(3rd of a Series)

Ground, Hardened, Tempered, and finally polished and inspected under a microscope

When you consider that a diminutive pill box holds nearly 5000 pivots for the movable element bearings of Brown Pyrometers, you will appreciate what problems are involved in their production and inspection. In making these pivots of a superior quality, special drill rod .020″ diameter is taken and ground to a point with a 50° angle. The pivots are then hardened and tempered, placed under a microscope and carefully polished. The pivots are finally inspected under the microscope in the hands of an inspector.

The jewels are made of imported sapphire of the finest quality, ground to a conical hole at an angle of 80°, then carefully polished and inspected.

You can readily understand that the 50° angle glass-hard pivot bearing in an 80° smooth sapphire jewel, produces a system that is as nearly frictionless as possible to obtain. In a vertical pivoted system the lower pivot takes the small weight of the movable element and the top pivot is only a guide. It is frictionless—the system is floating—so to speak.

This is another example of the methods employed in the manufacture of Brown Pyrometers which has made them pre-eminent in the measurement of high temperature.

The Brown Instrument Company
4505 Wayne Avenue, Philadelphia, Pa.

New York Boston Pittsburgh Cleveland Detroit Chicago
St. Louis Birmingham Denver Los Angeles San Francisco Montreal

Brown Pyrometers
Most used in the world

(When writing to advertisers, please mention the JOURNAL)

SOLE IMPORTERS OF

KRYOLITH

GENUINE GREENLAND
FOR THE GLASS AND ENAMEL TRADES

MANUFACTURERS OF

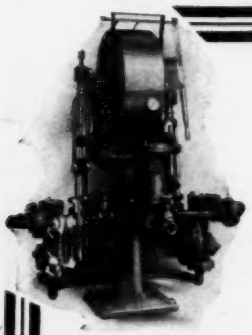
NATRONA
HYDRATE and OXIDE
FOR THE GLASS, ENAMEL AND PORCELAIN TRADES

ALUMINA

And Other INDUSTRIAL CHEMICALS

Pennsylvania Salt Manufacturing Co.
PHILADELPHIA, PA.

New York Pittsburgh St. Louis Chicago



THE MUELLER PUMP

Is assisting the most progressive potters in improving their ware.

Do you know the advantages of this pump and how it is increasing production?

Why not give us the opportunity to explain.

Our catalog is yours for the asking

THE MUELLER MACHINE CO., Inc.
TRENTON, NEW JERSEY
P. O. BOX 758

1
eans 1922

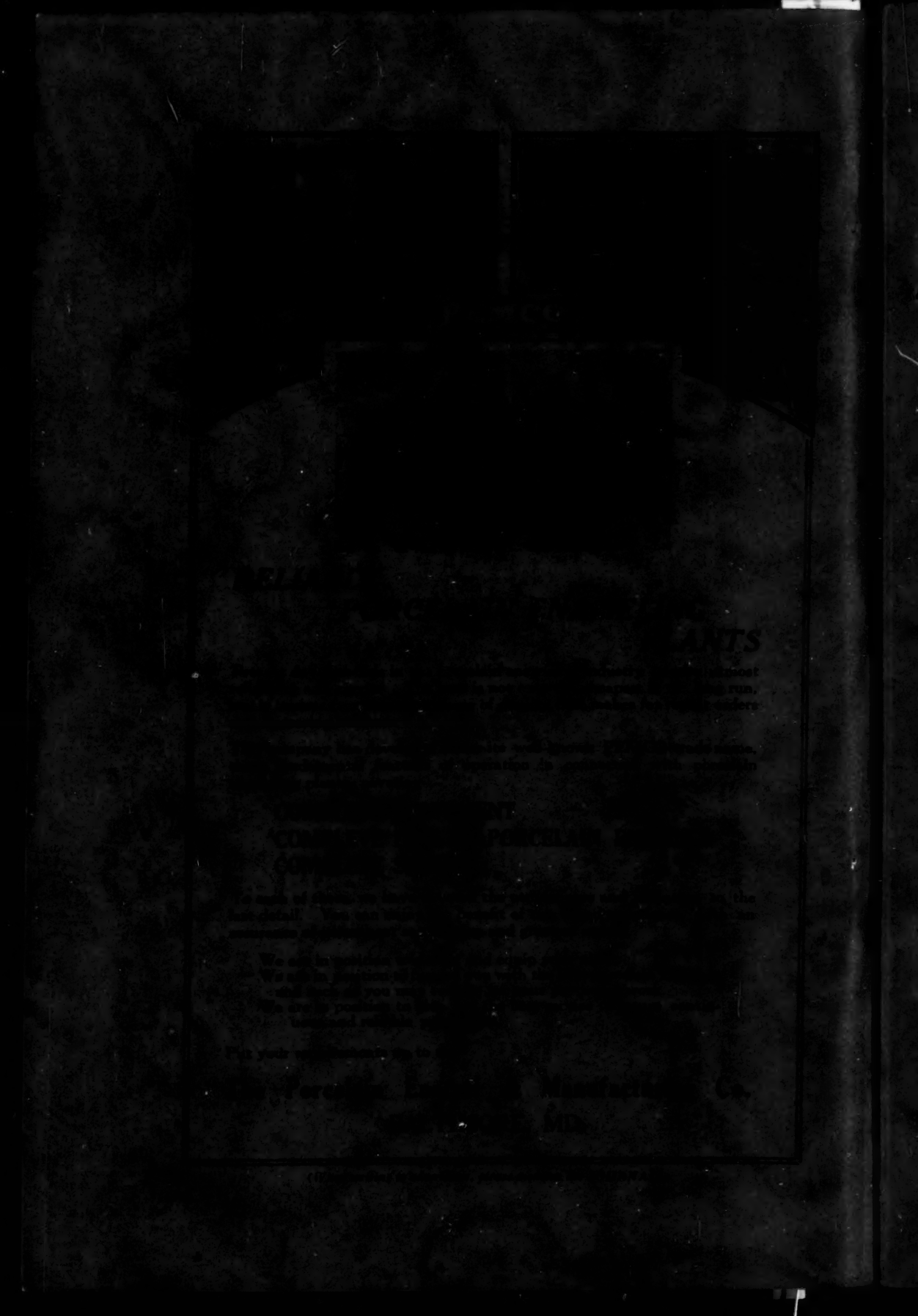
TH YEARS IN THE GRAND OLD SCHOOL
OF EXPERIENCE

nd DOMESTIC

CL

CERA C

PURPOSES

P
QUALITY AND PRICE

P mporting Co., Inc.
ENNA.